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OBITUARY NOTICE

FRANCIS AVELING, 1875–1941

GRAVE is the loss that has just befallen psychology in the passing of the familiar figure of Francis Aveling.

His academic career was exceptionally distinguished. Born in Canada in 1875, he was educated at Bishop Ridley College; at McGill University; at Keble College, Oxford; at Canadian College, Rome; at the University of Louvain; and University College, London. He obtained the degrees of D.Sc. and D.Lit. (London), Ph.D. (Louvain), and D.D. (Rome). At Louvain he was awarded first class honours and was elected fellow. At London he gained the Carpenter Medal. He has held many important posts, including numerous examinationships, the Presidentship of the British Psychological Society and (up to the last) the Chair of Psychology at King's College, University of London. During the previous war, in which he served as Chaplain, he was mentioned in despatches, given the M.C. and made Commander of the Order of Christ. He was married in 1925 to Ethel, daughter of Mr S. G. Dancy of Steyning, Sussex.

Like so many other profound thinkers, he was originally inspired by metaphysics, and in particular by the tremendous question as to "What is the ultimate nature of Reality?" But then forthwith, like all his predecessors, he found himself up against the hardly less baffling obstacle as to how such reality admits of being *known*. Obviously, however, all knowing consists in processes of cognition. And after this fashion he necessarily moved on from the field of epistemology to that of psychology.

Now of all the psychological resources for this critical function of knowing truth, by far the most widely credited throughout history has been provided by what have been called 'universal' ideas and propositions. These, as their name implies, extend their scope throughout time, space, and even imagination; whereas the knowledge afforded by sensory percepts is rigidly confined to here and now. What is still more important, the ideas have been credited with the cardinal virtue of being unchangeable; whereas the percepts are notoriously shifting from moment to moment.

Accordingly, it was these alone trustworthy ideas that supplied Aveling with his first main object of investigation. And he led off by examining their connexion with those more or less faint and fragmentary

perceptual reproducts that are commonly called 'images'. This connexion proved to be unexpectedly loose and wayward. Far from constituting the essence of the universal ideas, the images were in most cases absent. Indeed, they turned out eventually to be not indispensable even for thoughts of particular objects. Otherwise expressed, any kind of thought could be 'imageless'.

Even more vital, however, than this problem as to how these ideas are constituted, is that as to how they are created. And on this matter Aveling went ahead of all his predecessors. For these had supposed that such ideas could only arise by way of 'abstraction', at most 'combination', from antecedent experience, and therefore could never exceed the confines of this. For example, the universal idea of man was taken to be nothing more than an abstraction from more or less numerous percepts of individual men.

Aveling, on the contrary, found that the ideas were frequently of such a nature as neither had been, nor possibly could be, given in previous experience. In such cases they derive, not from any abstraction, but from the totally different process of 'educing correlates'. He writes:

> The presenting of any character together with any relation tends to evoke immediately a knowing of the correlative character. Thus one tends to think or imagine, say, a line half the length of a given line if the relation 'half' be in the mind.

To such eductive processes he attributes, for instance, the construction of the ideas of 'immortality' and of 'God'. He has been careful, however, to add some qualifications. Although such correlates do not necessarily *consist of* any parts or parcels of previous experience, it must needs at least be *generated by* these. Moreover, he has always maintained that the power of thinking such correlates neither proves nor disproves the existence of any corresponding reality.

Naturally enough, however, Aveling's pursuit of truth was not restricted to the aforesaid analysis of thought. It covered also the other great cognitive faculty, which is sensory perception, and which in point of fact is much the more complex of the two. To its manifold constituents and phases he and his numerous pupils devoted a long series of brilliant experimental researches. One notable fruit was the observation which he and R. Cattell made of the transition from the original merely 'felt' sensory experience to the knowledge of its nature. Another outstanding discovery in sensory perception was the previously mentioned process of educing correlates. By way of this process he was able to explain such fundamental events as the appearance of 'substance' and of 'force'.

Here we are led over to a new sphere of Aveling's main activity. It is one which, although still replete with philosophical interest, is no longer cognitive, but instead deals with the human Will. And at this point his achievements may be said to reach their climax.

He appears to have set out from the awesome problem as to the nature and origin of the idea of 'cause'. First of all, he confirmed the discovery by Malebranche (and afterwards by Hume) that nothing of this sort is disclosed in bare 'felt' sensory experience. As an illustration, he takes the case where a person seemingly perceives that 'water rusts iron'. Here, the person does not actually see any causation, but solely certain sequences of shape and colour. Causation can indeed be actually felt, he finds, but only in one privileged case. To understand this, he says, it is needful to distinguish two fundamentally different mental operations. One of these is properly entitled that of 'willing' (it includes resolving, deciding, determining and the like). The other operation he calls 'conation' (it takes in such things as trying and striving). He contrasts the two operations by noting the fact that "a decision made in a moment may have as its consequence a series of conations which last a lifetime". Now, it is between these two that causation (properly so called) was found by Aveling and his pupils to be actually felt and known to be so; on the direct evidence of consciousness, a person tries *because* he wills to do so.

From this primordial awareness of oneself as causing, and as simultaneously being caused, Aveling was able to proceed to other profound problems. For instance, he was able to show how the mind manages to escape from the toils of solipsism (see above). For when once any person knows himself to be causative, it is an easy step for him to regard other objects as being similarly so. "This process", he argues, "is one of applying one relation by analogy to another." It is, in fact, once more a case of educing a correlate.

So far our summary exposition of the great work of Aveling may to some readers seem to have been more philosophical than psychological. But this would be a misapprehension. In point of fact, he has been rather chary of discussing philosophy. He only claims to supply an extremely potent *approach* to this. Whether or not he has succeeded in substantiating this claim, his facts in themselves remain strictly psychological, as do his methods of obtaining them. Far from suffering from any philosophical or other narrowing bias, his work is singularly comprehensive and informative. From his multitudinous but scattered publications there could be constructed a General Psychology unsurpassed. Pending

such a desirable consummation, we must content ourselves with citing his publications in their present forms.

Among his books may specially be mentioned the following: *On the Consciousness of the Universal and the Individual; Confirmations expérimentales d'une théorie du processus cognitif; Arnoul the Englishman* (novel)*; The Immortality of the Soul; Science and Faith; The God of Philosophy; Modernism; The Philosophers of the Smoking-Room; The Spectrum of Truth* (with Rev. A. B. Sharpe)*; Directing Mental Energy; The Psychological Approach to Reality.*

To the preceding volumes must be added his *Expository Essays in Christian Philosophy*, besides numerous contributions to periodical magazines.

Still more valuable, if in general less accessible, have been his lectures and the manifold researches made under his inspiration.

Even less available to the general public, of course, but in itself most precious of all, has been the conversation so generously bestowed upon his admiring and affectionate friends.

C. SPEARMAN.

OBITUARY NOTICE

SIR HENRY HEAD, 1861–1940

HENRY HEAD died in his eightieth year on the eighth of last October. As physiologist, neurologist, psychologist and physician, publishing brilliantly original research over an uninterrupted period of some forty-five years, he was one of the most distinguished workers in these combined fields whom Great Britain has ever produced. During the last Great War, he gave up his consulting practice and went to live in hospital, devoting all his time to research on, and to the treatment of, his soldier patients, and to various medico-psychological matters affecting the Fighting Services. But only a few years after the conclusion of the peace he fell a tragic victim to that incurably fatal disease of the central nervous system, paralysis agitans. He had already delivered in 1920 the Hughlings Jackson lecture on his studies of cerebral injuries in war-time; and he was just able in 1926 to publish his two monumental volumes on *Aphasia and Kindred Disorders of Speech*. Thereafter he lived a carefully planned life in retirement near Reading, devotedly nursed by his highly cultured and vivacious wife (née Ruth Mayhew) whom he had married in 1904 and who, to his irreparable sorrow, predeceased him in 1939. Both before and after their marriage, she had been an able literary critic of his scientific publications, to whom he always submitted them. To her, "without whose touch these strings would have been mute", he dedicated his volume of poems, *Destroyers and Other Verses*, published in 1919—a collection of original verses and of translations from German poems. His home at Hartley Court became a place of pilgrimage for many of his former colleagues resident both in this country and abroad. To the end he retained his old mental vigour and exceptionally wide interests, despite his slow but progressive loss of voluntary muscular power. He received the honour of knighthood in 1927.

Head came of Quaker stock. He was born in 1861 at Stamford Hill; his father, also a Henry Head, was a member of Lloyd's. From Charterhouse in 1880, where he obtained a scholarship, he entered Trinity College, Cambridge, where he also won a scholarship and, towards the close of his career, was elected to an honorary fellowship. After obtaining his B.A. degree with first class honours in Physiology in Part II of the Natural Sciences Tripos, he studied for two years in the German University of Prague. At Cambridge he had been greatly impressed by the

views and teaching of Walter Gaskell; to Prague he went in order to work under Ewald Hering; later, at the London Hospital, he came under the lasting influence of Hughlings Jackson. These remained to the end his three greatest heroes in the fields of contemporary physiology and neurology, "who", as he said, "have most influenced my methods of work and thought": to their memory he dedicated his last publication—his two volumes on aphasia.

When only twenty-three years old, he carried out in Hering's laboratory physiological experiments upon the action of the vagus nerve in respiratory movements, recording the latter by the use of a strip of the diaphragm (known henceforth as 'Head's strip'), which became a standard method of investigation. These experiments were published in *The Journal of Physiology*, 1889. In the autumn of 1886 he was back at Cambridge, investigating with characteristic thoroughness his first case of aphasia at Addenbrooke's Hospital and completing his anatomical and physiological studies for a medical degree in the University laboratories. He then entered University College Hospital for his clinical work, and took the Conjoint Diplomas of the Royal Colleges of Physicians and Surgeons and the M.B. degree of Cambridge in 1890. He became M.R.C.P. in 1894 and F.R.C.P. in 1900.

For the M.D. degree at Cambridge, which he took in 1892, Head submitted one of the most important theses which can ever have been written for the purpose: "On disturbances of sensation, with especial reference to the pain of visceral disease." This was published in an elaborated form in the pages of *Brain* for 1893, 1894 and 1896. The investigation began with a study of 'referred' cutaneous pain or tenderness associated with disease of the various viscera, the irritation due to which, Head supposed, opened up a nervous path normally inhibited by the action of cutaneous sensibility. He was led on to study the distribution of herpes zoster, an eruption of the skin associated with disease of the posterior root ganglia of the spinal cord. This distribution, the neurological implications of which had been simultaneously realized by James Mackenzie, was found by Head to coincide closely with the tender cutaneous areas which he had already traced in visceral disease. The areas affected became henceforth known as 'Head's areas'; their nerve supply was traced to the various segments of the spinal cord. These discoveries spurred him to investigate the nerve supply of the viscera, the cutaneous distribution of the posterior spinal roots, and, with Campbell, the primary and secondary, central and peripheral, nervous lesions occurring in cases of herpes zoster. He subsequently investigated the

hallucinations, etc., occurring in visceral disease, the results of which he gave in his Goulstonian lecture of 1901 to the Royal College of Physicians, London, entitled "Some mental symptoms associated with visceral disease in the sane", and published in *Brain* of that year.

A characteristic of Head's genius was the magnitude of the problems which he chose for attack. His other three *magna opera* consisted in an investigation of the disturbances and return of cutaneous sensibility after section of the external cutaneous and radial nerves, and excision of a short length of those nerves before suture, in his own left arm; in tracing, by means of clinical examination, the paths of sensory impulses throughout the cord and brain-stem to the optic thalamus and the cerebral sensory cortex, and in elucidating the functions of the thalamus and sensory cortex; and in a profound study of the nature and varieties of aphasia.

Another of his characteristics was his wise choice of able collaborators and advisers—W. H. R. Rivers and James Sherren in the first of these three investigations, Gordon Holmes and Theodore Thompson in the second, Elliot Smith and F. C. Bartlett in the third, and George Riddoch in a war study of the striking phenomena of the 'mass-reflex' occurring below the level of a lesion of the spinal cord. Most of the results of this series of truly epoch-making results were published in *Brain*, between 1908 and 1918. Of this journal Head was editor from 1910 until 1925. In it in 1915 he published Hughlings Jackson's far-sighted but long neglected and scattered papers on aphasia, dating from 1864 to 1893. Later, in his own great work on the subject, Head applied some of Hughlings Jackson's broad views (as the latter had not) to actual cases of aphasia. In 1919 many of Head's neurological papers were collected and published, in conjunction with his collaborators, in two volumes entitled *Neurological Studies*. His work with Gordon Holmes on "sensory changes from lesions to the sensory cortex and other cerebral lesions" formed the subject of the four Croonian lectures which he delivered before the Royal College of Physicians in 1911.

Yet another of Head's characteristics was the thorough and systematic manner in which he first prepared himself, and later reserved time, for his research work. After receiving his first medical qualifications, he filled house appointments at University College Hospital and at the Victoria Park Hospital for Diseases of the Chest. In 1894 he served as clinical assistant to the Lancashire County Asylum at Rainhill. Then he was appointed Medical Registrar to the London Hospital, becoming Assistant Physician there in 1898, later full Physician and finally

Consultant Physician. In the methods of experimental psychology he received his training at the hands of W. H. R. Rivers, while working with him in testing the recovery of sensibility of the skin after the section of two nerves in his own arm. Between 15 April 1903 and 13 December 1907, he had 167 days' sittings with Rivers in the rooms of the latter at St John's College, Cambridge, standard and improved tests of cutaneous sensibility being applied by Rivers to the affected regions of his skin. Every Friday or Saturday during this period, he used to travel from London to Cambridge, where rooms in college were allotted to him for the week-end. In later years he always set aside one day in each week for his research work: neither private practice nor any other engagements were ever allowed to desecrate this day.

His medical colleagues were not slow in recognizing the high standard of his research. From the Royal College of Physicians in 1897 he received the Moxon Medal, and from the Royal Medical and Chirurgical Society in 1903 he received the Marshall Hall Prize, conferred respectively every three and five years for the most distinguished and original work in clinical medicine carried out during those periods. He received the LL.D. degree at Edinburgh and the M.D. degree of Strasbourg. He was elected a Fellow of the Royal Society in 1899, served on its Council from 1915 to 1917 and as a Vice-President from 1916 to 1917, was awarded a Royal Medal of the Society in 1908, and delivered its Croonian lecture in 1921.

Head was a thick-set man of good stature, and of florid appearance which, with his short pointed beard and gold-rimmed spectacles, gave him somewhat the appearance of a foreigner. Indeed, he used to say that in his younger days he was frequently mistaken for a German by Englishmen when he worked in Prague. He spoke German remarkably well, and French also; it was characteristic of him that on a holiday he used to learn the most irregular of French verbs while dressing. He spoke, often excitedly, in a high-pitched voice. His thoughts were apt to vault, as it were, over obstacles which were non-existent only for him, so that it was not always easy for those of less intellectual brilliancy to follow the swift train of his expressed ideas. Few men have surpassed him in exuberance of imagination and in untiring energy: the irrepressibility of his genius was at times almost overwhelming. In him was to be found a rare admixture of intellect and emotionality, a combination of the characteristics of the scientist and of the artist. Yet he never allowed the brilliance of his imagination and the lightning speed of his conclusions to escape the later control of his scientific acumen. To the end he was intensely inter-

ested in drama, music, painting and literature, especially in poetry which he loved discussing with philosophically inclined poets. He was himself endowed with great dramatic talent, especially evident when he was portraying the voice, facial expression, gait and other movements of a sufferer from some nervous malady. Indeed, he would throw himself so wholly into the 'part' which he was assuming that one who did not know him well might suppose that he was suddenly stricken by the disease that he was imitating. He hated dishonesty and self-seeking. If he—rightly or even wrongly—suspected them in another, the latter at once forfeited his inestimable friendship. He was ever ready to encourage his abler pupils and to help even strangers in their personal difficulties. Always attracted to the wider problems of human affairs, he gave unstinted support to projects for the improvement of medical organization, its status and education. Thus he took an active part in the amalgamation of various independent medical societies to form the present Royal Society of Medicine, and he gave the University of Cambridge every encouragement to establish a Diploma in Psychological Medicine which, however, was allowed to lapse, for reasons of economy, after the end of the last Great War.

So wide was the extent of his scientific investigations that only a few of their most outstanding results can be mentioned here. Head's heroic researches on cutaneous sensibility resulted in a clear separation between 'deep' sensibility (to heavy tactual and painful pressure) and the two varieties of superficial sensibility which he came to distinguish as 'protopathic' and 'epicritic'. 'Deep' sensibility, he found, remains after the section of the cutaneous nerves: the afferent nerves subserving it run mostly with the efferent (motor) nerves. The features of protopathic sensibility were its 'spotted' distribution, its radiating, vivid, 'all-or-none' character, vague localization, loss of tactual discrimination and loss of adaptation. Touch was lost, save by mechanical stimulation of the hairs of the skin. Sensibility to hot and cold stimuli was retained, but warm and cool stimuli evoked no sensations of temperature. Protopathic sensibility was the first to return, followed slowly by epicritic sensibility with a gradual diminution of the characteristics of the protopathic form. In a small area of Head's arm epicritic sensibility was found at one stage, unaccompanied by the fundamental features of protopathic sensibility. With the reappearance of epicritic sensibility cool and warm sensations could be evoked, light touch began to evoke sensation, and graded sensibility, accurate localization, tactual discrimination, and adaptation returned.

These astonishing results provoked others to repeat Head's experiment, but usually in a more or less ambiguous and non-comparable form, and so producing variously different results. On the whole, his conclusions are accepted to-day by his fellow-neurologists, although doubts are entertained as to the sharp line which he drew between the protopathic and epicritic systems. More doubtful, however, is the evolutionary interpretation which he gave to the relation between these two systems. Here, doubtless, he was influenced by his collaborator, Rivers. Just as the latter, in considering the relation between instinct and intelligence, had supposed that in the evolution of the animal kingdom instinct arose first and intelligence was later grafted on it, so Head believed that the protopathic was phylogenetically the sole earlier form of cutaneous sensibility, to which subsequently the epicritic became added. Little evidence in support of this view can be adduced. It is probably as incorrect as is Head's view that the widespread, temporary, 'mass reflex' observed by him and Riddoch at a certain stage after spinal lesions represents a once primitive phase of the normal, more restricted, spinal reflexes.

Coming next to his study of the grouping of afferent impulses from the skin, subcutaneous tissues, muscles, tendons and joints, as the nerves enter and ascend the spinal cord, we meet with equally striking discoveries and acquire a clearer and surer knowledge of what was previously obscure or uncertain. Within the cord, the temperature impulses arising from his protopathic and epicritic systems immediately combine, the heat (protopathic) and warm (epicritic) together and the cold and cool together, so that injury to one spinal (or higher) area will result in the loss of one, whereas injury to another will result in the loss of the other, of these two pairs of sensations. They cross at once to the opposite side of the cord. A similar combination and crossing of tactual impulses—including localization, but excluding spatial discrimination (compass points) and the tactual appreciation of form and size—also, but far less immediately, occur after entry into the spinal cord. With intermediate speed, after entering the cord, the painful impulses of the peripheral systems of sensibility similarly combine and cross. These three separate tracts (for temperature, touch and pain) thus sooner or later cross to the opposite side in their ascent of the cord; whereas the tracts subserving (*a*) recognition of passive movement and posture from the deep system, and (*b*) spatial discrimination and appreciation of form and size from the epicritic, cross in the bulb just above the cord, and become grouped afresh, the sensory fibres of both groups travelling to the optic thalamus

and thence to the cerebral cortex. The impulses concerned with the recognition of movement and posture part company in the bulb with those concerned with spatial discrimination and appreciation of size, so that injuries above this level cause loss of one of these pairs without loss of the other. Many of the non-sensory fibres of the former group do not cross in the bulb but proceed by the direct cerebellar tract to the cerebellum.

With Holmes Head carried out most important work on the recognition of impulses in, and on the functions of, the optic thalamus. He showed how the functions of its essential organ are controlled by inhibitory impulses passing from the cerebral cortex to the lateral nucleus of the thalamus and how, when these impulses are removed by injury, affective over-responses result. When such injury is unilateral, sensory stimuli capable of arousing pleasure or displeasure may now evoke the most extreme delight or the most intolerable discomfort when applied to the opposite side of the body. But we are not justified in supposing that the essential organ of the thalamus is, as Head believed, "the centre of consciousness for certain elements of sensation". Under the above-mentioned conditions, the thalamus still preserves connexions with the cerebral cortex, and we have good reasons for thinking that without the activity of wide regions of that cortex consciousness in any form is impossible. No "centres of consciousness" are conceivable.

Head came to realize that "sensation, the final end" of the process of integration of sensory impulses, implying a change "from a complex to a simpler more specific grouping...assumes forms simpler than any sensory impulses". He concluded, from his study of lesions of the sensory cortex, that such lesions produce usually no true rise in threshold (especially the tactual and spatial threshold), but an irregularity and uncertainty of response (quite independent of the strength of the stimulus), making determination of the threshold often impossible. He regarded the sensory cortex as "an organ of local attention" and as being concerned especially in relating the new to the old—in discrimination, balance and clearness. He came also to the conclusion that it "registers and retains the physiological dispositions produced by past events", forming unconscious "organized models of ourselves" to which he gave the somewhat inappropriate name of 'schemata', by which sensations come to be charged "with a relation to something that has happened before". By means of such ever plastic models or 'schemata', non-conscious standards are constructed, only in relation to which "every change in posture, movement or localization can enter consciousness",

and on and by which it must be first recorded. These models or 'schemata' are variously destroyed in lesions of different parts of the sensory cortex.

In formulating this important conception of unconscious 'schemata' Head had reached the equally important conclusion that conscious 'images' of past movements can no longer be regarded as the basis of our recognition of bodily posture and movement. Such recognition depends both on the integration of afferent impulses with the unconscious 'schemata' and on the activity of those 'schemata'. Nevertheless, despite his recognition of the continual growth in elaboration and complexity of these 'schemata', Head allowed himself to speak of them as the 'storehouse' of past impressions: thus he was not yet wholly emancipated from the standpoint and terminology of an older psychology, which regarded images as being 'stored up' in the brain.

Head reached the peak of his psychological maturity in his last and perhaps most striking research—into aphasia. He began it when neurology was dominated by the 'diagram makers' who were intent on explaining aphasia and kindred disorders in terms of injury to various nerve 'centres' in the brain—visual and auditory word centres, glosso- and cheiro-kinaesthetic centres, etc., and to commisural nerve fibres connecting with and 'associating' such centres. They were able to uphold these preconceptions and prejudices by neglecting to make, or by failing to take into account, various clinical phenomena which contradicted them, or by their imperfect conduct of *post mortem* examinations. Like his master Hughlings Jackson, Head insisted on the difference between localization of the cerebral damage that destroys speech and localization of speech itself; the conception of localized 'centres' for normal mental functions rightly seemed to him an anachronism in modern cerebral physiology. Like Jackson, too, he realized that speech is a function of mental activity and that it presents therefore a problem primarily of a psychological nature; and that the loss of speech is fundamentally the loss of ability to formulate a proposition—which is more than a mere sequence of words. As Jackson had pointed out, words used non-propositionally or emotionally, e.g. "God bless me!" "Oh dear!" may still be uttered by the aphasic; he may also still be able to *receive* propositions. Speechlessness does not imply wordlessness, nor are words essential for all thinking.

Head excelled in bringing the precise, systematic methods of experimental psychology into clinical use. In the study of his cases of aphasia he stressed the importance of keeping the order of presentation of his test material constant, of proceeding from the easier to the more difficult

tests, of avoiding fatigue, boredom or loss of temper during the examination of his patients, and of repeating the tests on different days and at different stages of recovery owing to the variable results thus obtained. He realized the importance of the relations subsisting between physician and patient, one physician—like an interviewer confronting a candidate—obtaining different results from another. He was not content merely with recording the patient's responses, but also observed and interrogated him in regard to the facility of those responses and to the manner in which he carried them out. He found it impossible to classify his cases in any tabular form.

When he entered on the study of aphasia, Head quickly recognized that the disorders of speech are not due to the loss of images; these might be retained, although no longer available for voluntary use as part of "the symbolic mechanism of language". He also recognized that the 'pure' psychological tests, devised to investigate the analysed elements of sensation, perception, movement, etc., which he had employed in his previous researches, were now quite unsuited for his purpose. Like other workers in 'applied' psychology, e.g. in occupational selection, he employed 'sample', in place of 'analytic' tests—more 'complex' tests which imitated the experience and conduct of everyday life. Head realized that the sum of the separate parts was very different from the whole in any presented test situation. As he wrote in 1924 in one of the two papers which he published in this *Journal*, one or more functions associated with consciousness, when lost, "cannot be said to be the 'elements' out of which general consciousness is 'composed': they form rather forces in a psychical interplay" (p. 182). So, too, he insisted that the defects of aphasia cannot indicate the elements composing the use of language. They are to be described rather to a failure of the functions of "symbolic thinking and expression". He was careful to describe his tests in such detail that they could be reapplied by others, and to base his conclusions not on preconceived notions but on the recorded results of his observations. He came to distinguish four types of aphasia: (i) 'verbal', where the meaning and value of words are retained, but their formation (in external rather than internal speech) is affected; (ii) 'syntactical', where the syntax suffers through disorder of balance, time-order and rhythm, of articulation; (iii) 'nominal', where words (and other symbols) have lost their immediate meaning and cannot be fitted to objects; (iv) 'semantic', where the loss of meaning is far more profound, general ideas of what the patient has been ordered to do, orally or in writing, or of what he has read, being no longer possible, and the ability to combine

details into a consistent whole being lost. Although he admitted that broadly different cerebral lesions were associated with these four types of disturbances of speech, Head insisted that the use of language in speaking, reading and writing cannot be ascribed to the function of separate 'centres'. As he expressed himself in 1921 in the other article which he contributed to this *Journal*, "there is no reason to suppose that any groups of cerebral functions correspond to...'reading' or 'writing' or even to 'speech' itself. Any lesion which gravely disturbs 'speech' affects activities which are not usually classed with the use of language..." (p. 181).

Throughout his various researches Head had observed how closely neural and mental functions are dependent on the bodily and mental health of the individual. For example, headache, fatigue, or worry will cause the abnormal sensibility (e.g. numbness or loss of sensation) of the hand after cerebral injury to be temporarily replaced by the cessation of its very existence, owing, as he supposed, to a temporarily dormant condition of the cortical 'schemata'. Cold weather, during the recovery of the sensibility of his own arm after neural section, would throw its condition back from the epicritic to the earlier protopathic stage. Especially through toxic or slight narcotic influences, through so-called 'shock' immediately after the lesion, the reflexes observed in the spinal or decerebrate animal, or in a human patient suffering from a severed cord, will differ profoundly from their usual or later character. During the illness of a child previously liable to bed-wetting, this cured weakness may recur; owing to a cold or an internal 'upset', an expert skilled in an acquired act will lose his skill. All such lapses were summarized by Head as due to the loss of what he termed physiological 'vigilance'—a somnolence of the central nervous system, involving, apparently, both a loss of local alertness and a loss of control of the unconscious higher reflexes over the lower reflexes, and of conscious processes over the higher reflexes. However obscure and perhaps too comprehensive this conception of 'vigilance' may be, Head performed a useful service in bringing these various phenomena together and thus in calling attention to them. In this, as in so much of his other, research he performed pioneer work which it must be left to future generations, always admiring and mourning his loss, to refine and to complete. *His* highest-level 'vigilance' can seldom have been surpassed!

C. S. Myers.

TOPOLOGICAL PSYCHOLOGY AND NEUROGRAPHICS

By MAXWELL GARNETT

I. *Introduction* (pp. 15–18)
II. *Examples of equivalents* (pp. 18–29)
References (p. 29)

I. Introduction

When William McDougall, in one of the last of his writings (1), reviewed the 'Dynamic Principles of Gestalt Psychology' he 'wholly approved' of many of its leading features. At the same time he found much to criticize in the work of Wolfgang Köhler (2) and Kurt Koffka (3), but his criticisms were mild in comparison with his objections to certain views of Kurt Lewin (4). McDougall had not then seen Lewin's book on *Principles of Topological Psychology* (5). From this volume Lewin has omitted the so-called 'vector psychology' against which McDougall protested most strongly.

What remains is an attractive essay, clearly and forcibly written in simple language. It is admirably translated. And it provides a welcome introduction to the spatial representation of psychological phenomena. Lewin tells us, in his preface dated May 1936, that topological psychology began, more than ten years earlier, when it occurred to him "that the figures on the blackboard, which were to illustrate some problems for a group in psychology, might after all be not merely illustrations but representations of real concepts". Similar diagrammatic representations of real concepts had, however, already been derived from McDougall's 'hormic' psychology and published in England in 1921 (6). While the 'real concepts' represented in Lewin's diagrams are "quasi-physical, quasi-social and quasi-conceptual" ((5), p. 24), the real concepts represented in the earlier diagrams were simply physical: in fact, neurological configurations or neurograms. Yet, in view of the criticisms levelled by McDougall against Lewin's earlier volume, it is surprising to find how many and how close are the resemblances between Lewin's 'principles of topological psychology' and the 'neurographics' derived from McDougall's own work.

In this paper I use the word 'neurographics' to describe the methods of 'hormic' or neurological psychology which I employed in *Education and World Citizenship* (6) and in a recent shorter version (7) of that work. Neurographic psychology seeks to describe the working of the mind in

terms of brain processes. We may, perhaps, know more about the working of the mind than of the brain. But, as Sir Henry Head showed in his work on *Aphasia* ((8), vol. I, pp. 541 and 549), the states of mind revealed by introspection are 'categorical abstractions'. Although sensations, images and the like appear when the mind examines its own activities "they are not portions of an integrative reaction". The final thought follows from the brain processes but not necessarily from the intermediate thoughts. "The field open...to introspection is limited to the phenomena of consciousness." But many psychological processes are not included in these phenomena. Head's researches into the effects of injuries to the brain "reveal a multitude of processes which participate in the response", or influence the end of a train of thought, "although they do not form part of the continuum of consciousness and are not normally open to introspection". The same is true of processes described in Economo's account of *Encephalitis Lethargica* and its effects, both physiological and psychological (9).

Moreover, as T. H. Huxley pointed out, "there can be little doubt that the further science advances, the more extensively and consistently will all the phenomena of Nature be represented by materialistic formulae and symbols". By using them for the purpose of our reasoning we lessen the likelihood of mistaking the meaning of a proposition between the moment when we meet it for the first time as the conclusion of one syllogism, and the moment when we come back to it as the premise of another syllogism. Our reasoning is more likely to be accurate on this account: our conclusions will follow more certainly from our premises, and a comparison of these conclusions with the observed facts will show us more plainly if our premises or hypotheses are wrong. And if our conclusions accord with all the observed facts, we shall feel the more sure of the truth of our premises and of any other conclusions we may draw from them.

For these reasons, neurographics employs 'materialistic formulae and symbols'. Like topology, it is concerned with the spatial representation of psychological phenomena. Both neurographic and topological psychology employ 'real concepts' for the purpose of this representation[1] and both make use of diagrams to represent[2] their 'real

[1] "The system of concepts capable of bringing together the different fields of psychology in an empirical manner would have to be...suitable for the representation of general laws and of the characteristics of the individual case" (Lewin(5), p. 5). And again, "a set of concepts by means of which one can represent psychological reality" ((5), p. 6). Such a concept is "the psychological life space" ((5), p. 12).

[2] "What is meant by psychological life space and what must one take into consideration in order to represent it" ((5), p. 18).

concepts'. The real concepts of neurographics (neurograms and their excitement, synapses and their thresholds) have more in common than have those of topology (life space and its regions, points and paths, boundaries and dynamic walls) with the psychological phenomena which they directly represent. But, in the second stage of representation, the advantage is with topology: its diagrams and its 'real concepts' are more alike than are those of neurographics.

Again, both topology and neurographics consistently maintain unequivocal relations to the observable psychological data. Both represent the person and the environment—or so much of it as affects the person at the present moment—in common terms as part of one situation. Both represent causal interrelationships having compulsory consequences. Both representations are susceptible of mathematical treatment.

Many of the psychological situations and events represented topologically in Lewin's book have also been represented neurographically. Some examples are given below. In every case but one[1] the two representations are mutually consistent and have the same psychological consequences. Lewin's book also contains topological representations of other psychological situations which have not been, but might easily be, represented neurographically.

In topological psychology, or at least in Lewin's book with which alone we are here concerned, the representation of causal interrelationships is confined to psychostatics.[2] In neurographics, it extends to psychodynamics: the study of *change* in psychological situations or of the *flow* of consciousness. In this latter field topological psychology is content to be merely descriptive. It does not attempt to foretell events. Although Lewin refers ((5), p. 82) to 'dynamic laws', he gives no examples of what they are or how they operate. But neurographics has formulated five laws, three of them concerned with psychodynamics outside the realm of will. These three laws are cited below. Many examples of their working in everyday life are given in (7), pp. 90–93, 260–266.

[1] In this one case Lewin, on p. 181, represents the person as having the same motor as perceptual relationship to his environment. The person's links with his environment whether efferent or afferent are confined by Lewin's diagram to one and the same 'motor-perceptual region'. Lewin's representation would imply that when some incoming sense impression influences the 'outer regions' of the person and they in turn affect the 'inner regions', these latter cannot react directly upon the environment but the chain of cause and effect must reverse its path and go out by the way it came in. Neurographics could not allow such a breach of the law of forward conduction. See McDougall ((10), p. 132).

[2] Lewin does not use this word; but he makes many references to (psycho-)dynamics. The words psychostatics and psychodynamics occur in the first account of neurographics. See (6), p. 65.

Moreover, neurographics has represented many psychological situations and events which are not treated in Lewin's *Principles of Topological Psychology*. For example, conflict, purpose, character and 'will' have all been represented neurographically(7); but Lewin's book has only two sentences on conflict, two on 'will', and makes no reference to purpose or to character. Neurographics, again, has dealt more fully than topology with the nature and representation of knowledge. Neurographics has also sought to represent deduction and induction and the difference between these two ways of reasoning. Finally, neurographics represents instincts, interests and sentiments, none of which are mentioned in Lewin's book.

On the other hand, while neurographics discovers, lays down or assumes five laws of thought, topological psychology assumes only one law: that *to every psychological event there corresponds a system of spatial concepts*. This one law suffices for psychostatics. But neurographics can also represent the situations of psychostatics without using more than its first law: that *to every psychological event there corresponds a neurological event*. When, however, topology turns to psychodynamics and tries to describe, and account for, changes in psychological situations, it has to introduce several other assumptions, concerning 'dynamic "walls"' ((5), p. 126), the 'relative weight' of each situation at a particular moment (p. 138), the 'forces resulting from a situation' (p. 138), 'dynamic dependency' (p. 168), 'tension' (p. 174), and the like. But neurographics finds its five laws sufficient to ascertain and to represent the causes determining the flow of consciousness. The fourth of these laws concerns the 'will' and so falls outside the scope of Lewin's book. The three remaining laws are set forth in the course of the following examples of synonymous or equivalent 'real concepts' employed by topological psychology on the one hand and by neurographics on the other.

II. Examples of equivalents

In the following examples quotations from Lewin's *Principles of Topological Psychology* are printed in italics, with the page reference, and are followed, after the sign =, by their equivalents in neurographic terms. Some of these equivalents are quoted, in inverted commas with the page reference, from *Knowledge and Character*(7).

1. *Life-space* ((5), pp. 6, 12, 166) = Active nervous arcs and their neurographic connexions, together with 'will'.

Every psychological event depends upon the state of person and at the same time on the environment.... We shall use the term psychological life

space to indicate the totality of facts which determine the behaviour of an individual at a certain moment ((5), p. 12) = A man's actions are wholly determined, apart from his 'will'—as stated above, Lewin's book is not concerned with the 'will'—by nervous impulses (or excitement) in his brain or elsewhere in his nervous system, and by the neural links between the excited parts and other groups of linked neurones (or neurograms). Moreover, "action is the natural end of every thought" ((7), p. 260): the fifth law of neurographics.

Our neurograms "are partly innate and partly records of our own lives. They bring our past into relation with our present for the guidance of our future" ((7), p. 86). Adolf Hitler, for instance, considering whether the time has come for his next act of aggression, is influenced by the relevant facts as he knows them—by the physical environment, including the geography of the country he proposes to seize, the strength of its armaments and of his own, problems of commissariat and of economics; by the social environment, especially what his advisers, his party and his people expect of him; and by the spiritual environment, particularly his own aims, ambitions and dreams. He is not conscious of all these facts-as-he-knows-them at the same time. But they all influence his behaviour. They, and their relations to one another, are all represented among his neurograms. Lewin would say that the facts as Hitler knows them, facts of his momentary environment, are all represented in his psychological life space. Neurographics would agree that Hitler's behaviour will depend on the neurograms that represent all these things. It would add that his actual behaviour will follow from the momentary excitement (or 'activity') in his central nervous system according to three laws—of diffusion, of convergence, and of action: the second, third and fifth of its five provisional 'laws of thought'. These three laws govern the subsequent flow of the excitement through his neurograms, and therefore the course of his thought, unless indeed his thinking be redirected by his free will, the concern of the fourth law.

2. *The life space has to be represented by at least three dimensions* ((5), p. 199) = Neurograms are in three dimensions.

3. *All so-called psychological theories which do not contain a representation of the environment are...inadequate* ((5), p. 167) = Neurographics includes representations of the environment. "My neurogram of the object [in the environment]...is as much a real physical thing as the object itself. Indeed, my neurogram might be more real than its object: for example, if this were the square root of minus one" ((7), p. 60).

4. *Facts within the Life Space* ((5), p. 24)....*Facts are to be included in*

the representation of the psychological life space only to the extent and in the manner in which they affect the individual in his momentary state. We express this by calling them quasi-physical...quasi-social...quasi-conceptual facts ((5), pp. 24–27) = Among the active neurograms and their connexions which, apart from the person's 'will', determine his behaviour are his neurograms of physical things, of other persons, and of abstract conceptions. They are all actual, not 'quasi', facts. But they correspond to his knowledge of things, and (in so far as that knowledge is incomplete or inaccurate) not exactly to the things themselves.

A region in the life space ((5), p. 93) = A neurogram or a system of connected neurograms ((7), p. 57).

Each region which has the character of a thing ((5), p. 107) = The neurogram of a thing ((7), p. 61).

5. [*If*] *the field is unstructured with reference to cognition*, [*the result is*] *one's ignorance of the situation* ((5), p. 133) = "the more perfectly a man's neurography is organized [or 'structured'] to represent the objects in the world as well as the relations between those objects, the more extensive and the more accurate will his knowledge be" ((7), p. 84). For instance, to take one of Lewin's examples, I may want to go from the railway station in a strange foreign city to a certain house without having a map and without knowing where to ask for information. My ignorance of the situation means that, although both the station where I am and the house where I would be are represented among my neurograms, the route from the one to the other is not so represented. Therefore the excitement of the neurogram of my starting point, as I think of my predicament at the station, does not find its way to my neurogram of the house by any neural path of low resistance which corresponds, element by element, to any actual way from the station to the house. Thus I cannot think out any real way from my starting point to my goal; and, since I cannot find my way in thought, I cannot do so in fact. Reasoning solves the problem, and neurographics describes in detail how the process works. It is illustrated by the second diagram on p. 28 below. In brief, I concentrate upon a particular partial aspect of the problem before me. What should be my first move? Among the thoughts which then present themselves is that of walking out of the station and straight on until I meet someone who will understand and direct me. Again I concentrate on this idea to the exclusion of all alternatives. Action follows thought; and, sure enough, I find the help I need. The information thus obtained makes a neurographic link, representing the true facts, between my neurograms of the station and of the house.

Since I can now find my way in thought from the one to the other I can also move my body across the corresponding gap and reach my destination.

6. *Overlapping Regions....The cases in which two regions overlap... play an important role in psychology* ((5), p. 137) = "The same neurones and systems of neurones may form part of several different neurograms, just as the same movement may take place in several different reflex or habitual acts" ((7), p. 54). For example, a zoologist's neurograms for a dog and for a cat overlap in his neurogram for a carnivore. The important part played in psychology by overlapping facts, and by the neurograms that represent them, has been examined at some length in connexion with the organization of thought ((7), pp. 195–214).

7. *The breaking up of regions into subregions...can easily be treated mathematically* ((5), p. 155) = For a mathematical treatment of systems of neurograms and the elements into which they can be broken up, see (6), pp. 206–12.

8. *It is sometimes doubtful whether we should represent a psychological fact as a point or as a more-dimensional region* ((5), p. 110)....*In psychology the point is equivalent to a region which is not structured into parts* ((5), p. 112)="An ESSENCE is such a particular partial aspect of a fact as can only be thought of as a whole or not at all: an all-or-none fact of the world of experience" ((7), p. 198). To such essences, always used in reasoning, correspond 'elements' of neurograms ((7), pp. 195, 227, 252).

9. *Individual Differences* ((5), p. 182). *Even when from the standpoint of the physicist the environment is identical or nearly identical for a child and for an adult, the psychological situation can be fundamentally different* ((5), p. 24) = "If I know nothing, or not enough, of" a fact in my environment, it "is represented in my neurography by a neurogram from which elements corresponding to certain essences are missing. The fact is short-circuited" ((7), p. 227). To borrow an illustration from William James. "Suppose I say when offered a piece of cloth 'I won't buy that; it looks as if it would fade', meaning merely that something about it suggests the idea of fading to my mind—my judgement, though possibly correct, is not reasoned, but purely empirical." My neurogram of the cloth is 'short-circuited' because it lacks elements corresponding to the chemical constitution of the dyestuff, so that I cannot give the reasoned judgement that the cloth will fade because I know the dyestuff to be chemically unstable.

"Disputes between two or more people are often due to ignorance: to

the imperfect correspondence of their neurographies with the realm of facts and therefore with one another. Indeed, if we take account of affective as well as of cognitive neurograms, all disputes may be attributed to neurographic differences between the disputants" ((7), p. 228).

10. *The person is a differentiated region in the life space...a highly differentiated object* ((5), p. 166) = "The central elements of the" neurography that is "best for the individual and for the community" to which he belongs "include those corresponding to the self and the self-regarding sentiment" ((7), p. 221). "The dominating position is in most cases occupied by, and the controlling function exercised by, the highly complex sentiment peculiar to man, the sentiment of self-regard" (quoted from McDougall in (7), p. 77). "Since some idea of my self enters into all my purposes the neurogram of my 'self-regarding sentiment'...forms part of my future interest-system" ((7), p. 157), i.e. the system of neurograms which are excited when I think about the future. "My neurogram of my self, including my self-regarding sentiment with all its powerful affects, is always active during my waking moments" ((7), p. 147).

11. *Psychological Dynamics* ((5), p. 59) = "psychodynamics" ((7), p. 86). "How one state of mind gives place to another....The flow of consciousness. To ascertain the causes determining this flow is the ultimate aim of psychology" ((7), p. 86).

The life space or parts of it often suffer strong and sudden changes ((5), p. 60). *One can represent the order of togetherness of the facts which exist for psychology only if one realizes from the beginning that the determination of spatial relations has to be based upon psychological processes and depends therefore on the nature and the laws of psychological dynamics* ((5), p. 63) = "Our problem is to formulate laws according to which our thinking proceeds" ((7), p. 86). "The system of brain paths followed by the excitement, together with its intensity at various parts of the system, ...define the thought at any moment" ((7), p. 87).

That the spatial structure of the life space depends on psychological dynamics itself shows the importance of the dynamical concepts. These are such concepts as cause of change, tendency, resistance, solidity, equilibrium, force, tension, etc. ((5), p. 63) = How neurograms and systems of neurograms "are formed and organized" ((7), p. 87) is seen in psychodynamics. Psychodynamics studies the causes determining the flow of excitement or nervous impulses through the neurones, forming them into neurograms, linking the neurograms together by lowering the thresholds or resistances between them, deepening or canalizing them, connecting them with the neurograms of affects (emotions and conations) and so increasing their

driving power, or influence upon the flow of excitement and thus upon thought and conduct.

12. *The concept of connectedness, for instance the distinction between separate and connected regions, the distinction between different groupings of regions, is...of prime importance for characterizing both the person and the psychological environment. Changes of connexion, especially the uniting and separating of regions, are just as important for the psychology of perception as for the psychology of intention, satisfaction or friendship* ((5), p. 54) = "The physiological basis of all these"—the formation of neural habits, the association of ideas, memory, purpose ((7), pp. 154–68), "satisfaction" (pp. 244, 246), "comradeship or friendship" (pp. 285–86)—"consists in systems of nervous arcs of low resistance: arcs, that is, with thresholds[1] of various degrees of lowness" (p. 52). These systems of arcs, or neurograms, may extend widely in the central nervous system. They are by no means confined to the roof-brain. A simple case of remembering may involve my emotions as well as my perceptions. For instance, I am on a visit to a university town and happen to see on the pavement a familiar face and figure. I can't recall the name, or where I last saw the man. But I am perfectly aware of my emotional attitude towards him: I respect and like him. I say to myself "It must be so-and-so" (naming the Master of a certain college in the university, a man with whom I recently discussed some problems of secondary education); for, although I cannot be sure of any of his features, I know quite well that he shares my interest in colleges and schools. Next day, I suddenly realize who he was. Not the man I imagined, but the head of a college in another university and a governor of a school I know well.

13. *The topological concept of 'path' that connects two points...plays a fundamental role in the constitution of psychological spaces* ((5), p. 54). Neural paths of low resistance play an equally fundamental role in neurographics. For example, if I have a problem to solve "I can only achieve my purpose by finding an indirect path from *A*", my starting point, "to *Z*", my goal, "and so avoiding *U*", a barrier on the direct path from *A* to *Z* ((7), p. 171). (See lower figure on p. 28 below.)

The space of free movement of a person [*is*] *a connected region* ((5), p. 100). Inability to move freely where there are no neurographic connexions is illustrated in Figure 5 ((7), p. 170). (See below, p. 28.)

14. *Tension is...a state of a region relative to that of another region*

[1] "When the intensity of excitement arriving at a synapse between two neurones is just sufficient to cause an impulse to pass along the second neurone, we...call this intensity the 'threshold' of the synapse" ((7), p. 35).

and it involves certain forces at the boundaries of the region ((5), p. 175) = Excitement is a state of a neurogram or of a system of neurograms. Its presence involves a tendency to spread or diffuse across the boundaries of the excited neurogram or system. "Excitement in any nervous arc tends to spread to every other arc that is connected to the first by synapses with thresholds low enough for that excitement to overcome. This law of diffusion is our second law of thought" ((7), p. 92). But "the extent to which the excitement spreads depends upon the relation between the intensity of the excitement and the thresholds of the synapses; and this varies between wide limits. If the brain is fatigued the synaptic resistances are high and the diffusion slight. The tired thinker finds that his ideas are lacking in wealth of meaning, his vocabulary is restricted, and his imagery poor" ((7), pp. 92, 93).

15. *Dynamic 'walls'....A high degree of communication corresponds to a weak wall* ((5), p. 126) = A high degree of connectedness corresponds to weak resistance or low thresholds. A high degree of connectedness between two systems of neurograms—my neurograms for General Allenby's campaign in Palestine and for General Wavell's campaign in North Africa, for example, since I have lately read Wavell's book on Allenby—implies the existence of weak resistance to the diffusion of excitement from one system to the other, or a 'weak wall' between them. The excitement of one system, A, will therefore tend to spread to the other, W. In this way the state of the one influences the state of the other. Lewin writes: *By degree of communication of a region* [A] *with a region* [W] *we understand the degree of the influence of the state of* [A] *on* [W] ((5), p. 126).

Moreover, as Lewin observes ((5), p. 127) and as the law of forward conduction in nervous arcs might lead us to expect, the degree of communication, or weakness of resistance, may be greater in one direction than in the other. Since Wavell has written almost all I know of Allenby and since I know and am deeply stirred by other work which has lately kept Wavell very busy, my thought is much more likely to pass from Allenby to Wavell than from Wavell to Allenby.

Dynamic walls which may suffice to separate part systems to a high degree, if the forces in question are small, can become relatively unimportant in the face of the strong forces which arise during a state of high tension ((5), p. 189) = Thresholds which prevent the spread of excitement when the degree of excitement is low, are relatively unimportant when the excitement is high ((7), p. 93). "If the excitability is normal but the excitement intense, the nervous impulses may be diffused more widely

than usual, so that thoughts may become unusually rich in meaning, and capable of expression in uncommon language" ((7), p. 93).

Dynamic Dependency....The dynamic interdependency of two regions implies that the state of the one is influenced by the state of the other. It coincides therefore with the concept of dynamic communication ((5), pp. 168, 169) = Two interconnected neurograms—i.e. two neurograms separated by low thresholds—will tend to be excited together or in quick succession because, according to the law of diffusion (see no. 14 above), excitement tends to spread from one to the other. Thus the state of dynamic potency of one, or its power to influence the flow of thought according to the law of convergence (see no. 16 below), depends upon the state of the other.

16. *The Relative Weight of Situations* ((5), p. 137) = The relative intensity of excitement of systems of neurograms ((7), p. 104).

A child may be eating and at the same time listening to the song of a bird. The listening can be the major and the eating the minor activity or the reverse. Between two extremes many transitions are possible. Such cases of doing two things at once *are of common occurrence. But they offer considerable difficulty for description as well as for treatment of their dynamic facts* ((5), p. 138). A number of such cases have been described and treated neurographically ((7), pp. 111–15). Take for instance, Herbart's account of schoolboys whose minds are wandering until the teacher begins to tell a story. "No sooner did the words awaken old thoughts, forming strongly connected series with which the new impression easily combined, than out of new and old together a total interest resulted which drove the vagrant ideas below the threshold of consciousness, and brought... settled attention into their place(11)" ((7), p. 109). Lewin writes: *One can say in such cases that the person...is in two regions at the same time. Each of these regions is usually well structured and has the character of a situation....If two or more situations overlap in such a way, each situation possesses at a particular moment a certain 'relative weight' (importance, potency) for the person. The change of this relative weight is a dynamically important process* ((5), p. 138).

To return to Herbart's account of the idle schoolboys. The "instruction being uninteresting, and discipline relaxed, a buzzing murmur was always to be heard, which invariably stopped for as long a time as an anecdote lasted. How could the boys, since they seemed to hear nothing, notice when the anecdote began?" ((7), p. 112). Neurographics gives the answer. According to its third law of thought, the law of convergence, "of all neurograms that include arcs of the higher level, the most excited tends to drain the excitement from the others" ((7), p. 104). And, since

"every interest-system maintains its activity for some time after being excited", it follows that "when once any considerable interest-system—especially if it be rich in emotional elements—has been stimulated, it will tend for some time to reinforce the excitement of any neurograms connected with it, and so to make the excitement of other higher level arcs drain through them. An [active] interest thus tends to bring into the focus of consciousness whatever thoughts have any connexion with it" ((7), p. 108). Thus the process plays an important part in guiding thought.

Moreover, a corollary from the third law is that "of all active neurograms involving higher level arcs, that which is connected with (or forms part of) the widest and deepest interest-system tends, other things being equal, to drain the excitement from the rest" ((7), p. 110). And therefore, in the case of Herbart's schoolboys, "so soon as the neurograms excited (although very slightly, so that the corresponding thoughts never got beyond the fringe of an inattentive boy's consciousness) by the teacher's talk began to have connexions with an interest-system, although inactive, these neurograms tended to drain the impulse from all the others then active. Thus the corresponding thoughts came into the focus of consciousness. The interest-system was at the same time rendered active and maintained the boys' attention so long as it kept on being re-excited by the anecdote" ((7), pp. 112, 113). Here is an illustration of what Lewin calls a change in the relative weight of two situations: the teacher's talk, as he launches into an anecdote, becoming suddenly of *greater 'relative weight' (importance, potency)* in the minds of the boys than the competing thought. But neurographics is not content to observe that *the change of this relative weight is a dynamically important process*: it seeks to discover the process itself.

Again, Lewin observes that *Psychological regions of the environment can show very different dynamical properties* ((5), p. 115). *The fact that certain regions in the psychological environment* (like the teacher's talk in Herbart's experiment) *and within the person* (like the boys' interest in the subject of the anecdote) *influence other regions, both of the environment and of the person, may be taken as a criterion for connectedness in the topological sense* ((5), p. 54).

17. *The forces which result from a situation seem—other things being equal—to increase and decrease with the relative weight of this situation* ((5), p. 138) = The influence of an active system of neurograms, such as that corresponding to the boys' interest in the topic of the teacher's story, upon the flow of excitement, and so upon the person's thought and action, increases and decreases with the relative intensity of the

excitement of that system. This is a direct consequence of the law of convergence ((7), p. 104) quoted in the preceding paragraph.

18. *Dynamic unity of the whole person* ((5), p. 184) = The extent to which the self-system of neurograms is integrated, or interconnected, or free from high thresholds between its parts. To a perfectly integrated mind would correspond a single wide interest-system ((7), p. 236).

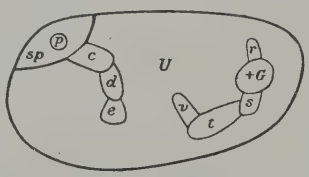
19. *Whole regions of the same degree of differentiation show a stronger dynamic unity if their part regions are less separated from one another* ((5), p. 184) = Other things being equal, a system of neurograms (the self-system, for example) exercises a stronger influence upon the person's thought and action if it is highly integrated, i.e. if its constituent neurograms are less separated from one another, or separated by lower thresholds.

This follows from neurographic laws. For, if the corresponding thresholds are lower in system A than in the otherwise similar system B, then the excitement of any part of A spreads (according to the law of diffusion) more easily to the whole of A than equal excitement in the corresponding part of B would spread to the whole of B; and therefore (according to the law of convergence) A will tend to be more dynamically potent that B, or to exercise more influence on the flow of excitement and so on the person's thought and behaviour.

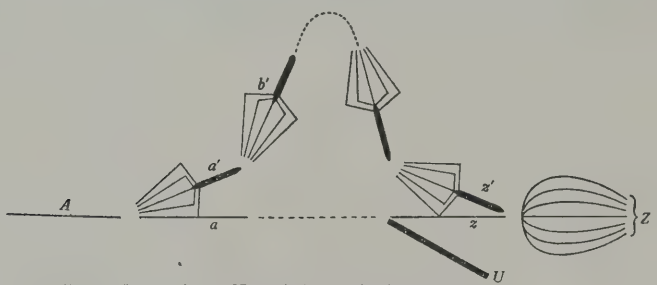
20. *Unsolved...problems* ((5), p. 131). *We shall call boundaries (boundary zones) which offer resistance to psychological locomotion 'barriers'* ((5), p. 124). "A typical case occurs when the fulfilment of a purpose is obstructed by sense-impressions, whether from inside or outside the body" ((7), p. 169).

We shall speak of barriers of different strength according to the degree of their resistance ((5), p. 124). *If one wants to overcome a barrier, one usually does it not by continuing the original kind of locomotion with increased efforts but by choosing another kind of locomotion against which the barrier is weaker. The problem which the barrier sets is essentially one of finding the most suitable kind of locomotion or communication* ((5), p. 130). "Suppose, for example, that I wish to unscrew a metal lid from a glass jar. My first thought is of the jar with the lid stuck fast. Its neurogram is represented by A" (see lower figure overleaf from (7), p. 170, but first published in 1921). "My purpose is to grip the jar tightly with one hand and the lid with the other, and to twist one hand round the other without my fingers slipping. To this complicated movement corresponds the excitement of Z. When the movement takes place and Z drains the excitement the lid is unscrewed. But if the lid is stuck very fast a great

effort of my will is required in order that I may grip the jar and lid so tightly that, when I twist my hands, my fingers shall not slip. Ultimately, a point is reached when the pressure on my fingers hurts [too] much.... The unpleasant feeling, and the relaxation of my grip that results from it, corresponds to the excitement of U in the diagram. If the lid begins to turn before the unpleasant feeling becomes too great, I have excited the direct path $Aa \ldots zZ$ sufficiently to lower its resistance[1] below that of the path $Aa \ldots U$. But if a direct effort of will is unequal to this task, I can only achieve my purpose by finding an indirect path from A to Z and so avoiding U. Reasoning is the process by which the will may make a new indirect path of this kind": $Aa'b' \ldots z'Z$ ((7), pp.170–171).



Reproduced from *Principles of Topological Psychology*, Fig. 23*c*, p. 132, by kind permission of the McGraw-Hill Publishing Company, Ltd.)



(Reproduced from *Knowledge and Character*, Fig. 5, p. 170.)

Fig. 1.

The process is described in detail and represented neurographically on pp. 171–72. It is further examined on pp. 249–51. Lewin's topological diagram (see reproduction in Fig. 1 of (5), p. 132, Fig. 23*c*) and his representation in general terms of the solving of such problems *by finding the most suitable kind of locomotion or communication* ((5), p. 130) *from the starting region sp to the solution G* (p. 131: see the upper figure) needs remarkably little change to fit its equivalent in the neurographic account illustrated by the lower figure where A is the starting point and Z the goal. But the topological representation provides no equi-

[1] How this is done is the subject of the fourth law of neurographics, concerning the action of the 'will': see above, p. 18.

valent to the neurographic representation of the psychological processes in detail. Lewin writes: *The situation often develops in such a way that the person* [or reasoner] *succeeds in finding a region r* (*Fig.* 23*c*) *which is connected with G* [the goal, *Z*] *and which he hopes to reach more easily from sp. Little by little there can appear a larger group of such regions connected with G* (*r; s, t, v*). [The neurogram *z'* in my Fig. 5 is equivalent to the region *s* in his Fig. 23*c*.] *At the same time one usually tries to find more regions connected with sp* (*c, d, e*) [or more neurograms connected with *A* such as *a', b'*...in my Fig. 5] *in such a way that one can hope finally to build a bridge from the starting region sp* [the starting neurogram *A*] *to the solution G* [*Z*], i.e. *a series of regions the topological sum of which* $sp+c+d+e+\ldots+v+t+s+G$ *is a connected region* [a series of neurograms of which the sum $Aa'b'\ldots z'Z$ is a connected system]. *When one has to reach a certain region by moving through an unstructured zone it often remains uncertain, as long as one has not really completed the bridge, whether the regions s, t, v and c, d, e, which are developed at first, will or will not serve as an approach to the solution* ((5), p. 132). How "the missing link between A and Z" often "forces itself on our attention" during a "period of unconscious work" after being "sought unsuccessfully during our first period of conscious work" is discussed in (7), p. 250.

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EXPERIMENTALLY INDUCED VISUAL PARAMNESIAS

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From the Cambridge Psychological Laboratory

I. *Introduction* (pp. 30–32)
II. *Experimental method* (pp. 32–35)
(1) *Material* (pp. 32–33)
(2) *Subjects* (p. 33)
(3) *Procedure* (pp. 33–35)
III. *Results with Subject W* (pp. 35–41)
IV. *Results with Subject M* (pp. 41–44)
V. *Results with other subjects* (pp. 44–46)
VI. *Quantitative data* (pp. 46–47)
VII. *Discussion* (pp. 47–50)
VIII. *Summary* (p. 51)
References (p. 51)

I. Introduction

This paper is concerned with a class of experiences to which we shall give the title *restricted paramnesias*. These experiences, commonly described as feelings or impressions of familiarity, are associated with a local failure of recognition. They are provoked by, and refer to, some more or less well-defined aspect of a perceptual situation. This aspect is always referred to the past history of the individual, but it cannot be endowed with an adequate localization in place or time.

We wish to distinguish restricted paramnesia from so-called *déjà vu*. In *déjà vu* there is always present the illusion of reliving a situation in its entirety, and the illusion is not obviously initiated by an isolated feature and always bears upon the situation as a whole. *Déjà vu*, moreover, may relate to a situation lacking all parallel in the history of the subject. Paramnesia, on the other hand, in its localized forms, almost always turns out to have a genuine foundation in past experience.

It is often argued that these two types of paramnesia can be ascribed to a common origin. MacCurdy (6), for example, claims, first, that every *déjà vu* has its source in a restricted paramnesia, and secondly, that it

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represents a mode of rationalizing this paramnesia. There is a certain amount of evidence in favour of this view to which we shall return at a later stage. For the present, however, we wish only to emphasize that the experiments to be described below are primarily concerned with paramnesia in its localized aspects. Their relation to classical *déjà vu* is conjectural.

Our purpose in this paper is to demonstrate that *restricted paramnesias can be elicited under controlled experimental conditions.*[1] We argued that if, as appears likely, the so-called experience of familiarity depends upon some check to recognition in its cognitive aspects, then the introduction of an artificial resistance should suffice to provoke the phenomenon. If a subject is artificially prevented from recalling the conditions of an earlier perception, might he not experience a paramnesia if this perception is repeated?

Our experimental procedure was briefly as follows: Material, both visual and olfactory, was presented to the subject in the ordinary waking state. On the following day he was hypnotized and other material of the same kind presented under otherwise comparable conditions. At the same time, we endeavoured to induce a selective post-hypnotic amnesia for all the material given under hypnosis. On the third day of the experiment, the subject was tested for recognition in the waking state. The material given comprised all the items given on the two preceding days together with some completely new control material. Responses given to all material on this session were recorded *verbatim.*

Our procedure set up three distinct expectations in regard to the material shown under hypnosis: (1) That it would be treated in exactly the same way as the material shown at the first, waking, session, thus implying breakdown or failure of the post-hypnotic suggestion. (2) That it would call forth responses identical in character with those given to the control material. (3) That it would call forth responses having the general character of restricted paramnesias. The second expectation, if fulfilled, would signify an absolute failure of recognition for the material[2] of the

[1] This finding has been reported briefly in an earlier communication(2). It has also furnished the theme of a paper read at a meeting of the Bedford College Psychological Society in Cambridge on 22 November 1939 and at a meeting of the Scottish Branch of the British Psychological Society in Edinburgh on 1 February 1941.

[2] The expectation of an absolute as opposed to a relative failure in recognition is strengthened by Strickler's results on post-hypnotic amnesia(8). This author found that visual characters learned during hypnosis were not recognized by the subject on awakening from the trance. In discussing this experiment, Hull writes that "the subjects invariably said that they had never seen the characters before, thus showing a perfect symbolic amnesia" ((4), p. 134). Claparède(3) reports analogous findings.

hypnotic session. The third expectation, if fulfilled, would imply only a relative failure of recognition and might throw light on the origin of paramnesia in daily life.

We shall consider in this paper only the visual material and the responses to which it gave rise. Olfactory paramnesias will be discussed in a later paper.

II. Experimental method

(1) *Material*

The material comprised twenty-four picture postcards selected more or less at random. With very few exceptions, none of the pictures was at all generally known. The cards were divided into three sets of which the first two comprised six cards each and the third twelve cards.

The first set, called *Series A*, was always given to the subject on the first day of the experiment in the waking state. The second set, *Series B*, was given on the following day under hypnosis. The third set, *Series C*, was given together with the other two series on the third day as a part of the recognition test.

Series A. This series comprised the following six cards:

A 1. *Belgian Church:* an uncoloured photograph of a little-known church.

A 2. *Three Flints:* an uncoloured photograph of three prehistoric flints.

A 3. *Dutch Women:* a coloured photograph of a group of women in national dress.

A 4. *Still Life:* a coloured reproduction of a little-known oil-painting. A flask of wine and some brightly coloured flowers were prominent.

A 5. *Venetian Scene:* another brightly coloured reproduction.

A 6. *Still Life:* a coloured reproduction of an obscure oil-painting showing two game-birds, a blue tankard, and other objects.

Series B. This comprised the following six cards:

B 1. *Japanese Print:* a coloured reproduction of an obscure print. It showed a girl in Japanese costume, a fan, a lantern, and some peacock feathers.

B 2. *Nine Flints:* an uncoloured photograph of nine prehistoric flints.

B 3. *Still Life:* another coloured copy of an obscure still-life in oils. A number of game-birds, a game-bag and a gun were prominent in the picture.

B 4. *Church Interior:* a coloured reproduction with a peculiar reddish hue.

B 5. *Egyptian Girl:* a coloured photograph of an Egyptian girl with an earthenware pitcher on her shoulder.

B 6. *Reynolds's "Marquess of Crewe":* a reproduction in colour of the celebrated picture. This was the only picture in the series likely to be at all widely known.

Series C. This series comprised twelve cards:

C 1. *"Coming Through the Rye":* an illustration of the popular theme.

C 2. *Mulready's "The Sonnet":* a coloured reproduction.

C 3. *Church:* a plain reproduction of a little-known German church.

C 4. *Junk:* a Chinese water-colour.

C 5. *Church Interior:* a coloured reproduction of an unnamed church.

C 6. *Three Flints:* an uncoloured photograph similar to A 2.

C 7. *Dutch Peasants:* a coloured photograph.

C 8. *Still Life:* a copy in colour of a little-known oil-painting. A stag suspended by the legs was the most prominent feature.

C 9. *Still Life:* a coloured copy of a picture showing fruit and leaves.

C 10. *Marseilles Harbour:* a view of the town and harbour.

C 11. *Nine Flints:* a plain photograph of nine prehistoric flints strongly suggesting B 2.

C 12. *Rottingdean School:* a plain photograph of the school library.

A comment on the *degree of similarity* between the cards in the various groups is in place:

(1) *Still Life.* All these cards were made by the same firm and had a certain generic resemblance. A certain thread of similarity ran through the pair A 4 and C 9 on the one hand, and through the group A 6, B 3, and C 8 on the other. But there was a great deal of difference, both in arrangement and detail, between the individual cards in both groups.

(2) *Prehistoric Flints.* The four cards A 2, B 2, C 6 and C 11 all depicted prehistoric flints of the same general type. The resemblance between A 2 and B 6 (Three Flints) on the one hand, and between B 2 and C 11 (Nine Flints), on the other, was extremely marked. Either of these pairs could fittingly have been used in a test of normal differential recognition.

(3) *Church Interiors.* There was some slight similarity of content between the cards B 4 and C 5 (Church Interiors). This was not sufficiently marked to lead one to expect any confusion on an ordinary test of recognition.

The *order of presentation* of the cards on the recognition test was always as follows: (1) C 1, (2) C 2, (3) A 3, (4) C 3, (5) B 3, (6) C 4, (7) A 1, (8) C 5, (9) B 1, (10) C 6, (11) A 6, (12) A 5, (13) C 7, (14) C 8, (15) B 2, (16) B 4, (17) C 9, (18) A 2, (19) C 10, (20) B 5, (21) A 4, (22) C 11, (23) B 6, (24) C 12.

(2) *Subjects*

Five subjects (W, P, E, Y, and M) took part in the investigation. Four of these were undergraduates, the fifth a young army officer. Their average age was 22 years. All five had been hypnotized once previously by one of us (H. B.).

The results given by two of the five subjects will be presented in full. In the remaining three cases the amnesia was less complete and the results of much less interest. For purposes of comparison, however, these results are outlined in § V.

(3) *Procedure*

A brief outline of the procedure has already been given. It will be remembered that three separate sessions were demanded in each case.

These we may call *Waking Session I*, *Hypnotic Session*, and *Waking Session II* respectively. The procedure on each session was as follows:

Waking Session I. The subject was first told about the object of the experiment. This, we said, was to investigate the relation between susceptibility to hypnosis and 'suggestibility' in perception. The problem was intentionally stated in this vague way in order to minimize the connexion between the waking sessions and the events of hypnosis. No clue was given as to the true object of the experiment. Usually an abbreviated Rorschach test was introduced on the first session to point our explanation.

Exposure of the cards was undertaken without special apparatus. The instructions were as follows: "This is an experiment on perceiving. I am going to show you a number of cards and I want you to look carefully at each card that I show. Each card will be exposed for 30 sec." The cards were then placed successively on the desk in front of the subject for the stipulated time interval. Comments were not recorded, but at the end of the series the subject was asked whether he had seen any of the cards before.

Presentation of the test odours followed immediately. The method will be described later in connexion with that part of the experiment.

Hypnotic Session. This session was usually conducted in another room. In the case of Subject M, however, all three sessions took place in the same room in order to control for possible differences of locality. The subject was hypnotized by one of us (H. B.), the other keeping a careful record of the procedure. Hypnosis was induced in the ordinary manner (see, e.g. Banister(1)), and generally carried to a stage of moderate depth. We agreed that the depth of hypnosis was greatest in the case of W, moderate in the case of P and M, and comparatively light in the other two subjects. The details of procedure varied slightly from case to case, but the text of the instructions was always adhered to rigidly.

Exposure of the cards was prefaced by the following instructions: "I have here a number of cards. I am going to show them to you one by one. I want you to look at each card very carefully. You have half a minute in which to look at each card." The subject was then told to open his eyes and was given the first card to scrutinize. On its removal after 30 sec. he was told to close his eyes and given the following suggestion: "After you wake up, you will have forgotten all about this card, and you will *not* be able to recognize it if it is shown to you to-morrow." The subject was then given the second card and told to look at it very carefully. On its removal, the above suggestion was repeated. The remaining four cards were then given in the same way, the suggestion that he would forget being repeated in exactly the same words each time. At the end of the series, a more generalized reinforcing suggestion was given: "When you wake up you will have forgotten all about these cards, and you will *not* be able to recognize any of them should they be shown to you to-morrow."

The method of presenting the odours will be described elsewhere. But a further generalized suggestion was repeated at the end of their exposure: "After you wake up, you will have forgotten all about the cards and also all about the odours. You will forget all about them. You will not be able to recognize the odours and you will not be able to remember their names. You will not be able to recognize the cards. You will have forgotten all about the cards and all about the odours, and you will not be able to remember that I presented them to you."

The subject was generally awakened shortly after the above suggestion was given. Precautions were always taken to remove all trace of the odours before the subject was awakened.

Waking Session II. The subject was tested for recognition approximately 24 hr. after the hypnotic session. He was told that the present session was a continuation of that begun two days previously. It was again emphasized that we were interested merely in visual and olfactory perception.

The sequence of test odours was generally given first. After the responses to these had been recorded, the series of twenty-four cards was given as already described. The instructions on this test were as follows: "Now I am going to show you a series of cards. This is also a test of your capacity to describe your own experiences. Look at each card carefully, *and then tell me anything that comes into your mind in connexion with each card*: What it is like, what it suggests to you, whether you have seen it before, whether it appeals to you or not, and so forth. You have 20 sec. in which to look at each card, but you need not wait until the card is taken away before starting to tell me about it." The interval between exposure of the card and the first verbal response was recorded. Supplementary questions asked from time to time by the examiner were recorded verbatim together with the answers.

The three stages of the experiment were conducted by one or both of the present writers in every case but one. In this case, *each of the three sessions was conducted by a different person.* The subject was M. *Series A*, on the first day of the experiment, was presented by Dr K.J.W. Craik. The hypnotic session was conducted by the present writers as in the other cases. Dr J.M. Blackburn conducted *Waking Session II* and presented all the material for recognition. Dr Blackburn was unaware of the constitution of the test series. He had not been told which (if any) of the cards had previously been shown in the waking state, which had been given under hypnosis, and which were entirely new. This procedure was adopted to reduce to a minimum unwitting suggestion on the part of the experimenter.

III. Results with Subject W

Subject W was a third-year psychology student with previous training in chemistry and physics. He was hypnotized readily in a preliminary session, and found to show a considerable degree of spontaneous post-hypnotic amnesia for the trance.

We shall consider the responses given by this subject to the three sets of material, A, given in waking session I; B, given in hypnotic session; and C, given in waking session II in the test of recognition on the third day. It is convenient, however, to divide the material as a whole into two classes: (*a*) *Unique Cards*, and (*b*) *Similar Cards. Unique* cards are all those cards in any series wholly dissimilar to any other member of any other series. *Similar* cards are those bearing a fairly marked resemblance to some other card in one of the other sets. These two classes may be taken one at a time.

(*a*) *Unique Cards: Series C.* Seven of the twelve cards comprising

this series may be treated as unique for present purposes. The subject's reactions to all seven were entirely in keeping with the normal reaction to unfamiliar material. We may quote two of these responses for comparison with the other groups.

C 1: "*Coming Through the Rye*". "I can't say I've seen that before. It's like 'Coming through the Rye'—Yes, I see it is that. It doesn't look like an English card."

C 4: *Junk.* "No, I havn't seen that. It's rather like some cards we've been using in the lab. Not the same, though. It also reminds me of the A.S.W. film 'The River'."

These two responses are entirely characteristic of the normal treatment of comparatively unfamiliar material.

Series A. Three of the six cards in this series were treated as unique. All three were instantly recognized and referred to the session on which they had been shown. We may quote one of these responses:

A 3: *Dutch Women.* "I've seen that before. I saw it on Monday (the first day of the experiment). I remembered it by the form of the main figures and the baskets; and on Monday I associated it with a Flemish picture."

The recognition in this case is prompt, decisive and circumstantial. There is some recall of the earlier reaction made to this card.

Series B. Three of the six hypnotic session cards can be classed as unique. These are B 1, B 5, and B 6.

B 1: *Japanese Print.* "I've seen that before. On some exotic sort of Christmas card or Japanese lantern. I remember the terrific 'eye' in the peacock's feather. I'm trying to connect it up with several things: First, the figure. Secondly, the Japanese lantern. And thirdly, the peacock's feather. I don't know—I think I associate the lantern with a Christmas card and the figure probably with productions of the *Mikado* which I've seen. But they don't fit in one whole. The peacock's feather fits in as an essential part of the thing, but doesn't seem to fit in with the rest. I can find satisfactory explanations for the other two things but not for the peacock's feather. But I think I've seen them as a whole."

This response is decidedly interesting. In the first place, there is an immediate judgement of reference to the past. In the second place, the subject adduces incorrect evidence in support of this judgement. In the third place, his rationalizations follow three entirely different lines, each of which is initiated by a different feature of the original card. These are never entirely harmonized to the subject's complete satisfaction.

A few additional questions were given in this case. These may be recorded together with the corresponding answers:

What was your experience on exposure of the card when you said: "I've seen that before"?—"A feeling that I'd seen it before—then that I hadn't but had seen parts. It's not one of the one's I saw on Monday." *Had the experience anything in common*

with those cases in which you thought you had smelt an odour before but couldn't remember exactly where or when?—"To a certain extent. With the odours it seemed I had smelt them before but couldn't place the time. With this I couldn't think of any possibility where I could have seen it before. I think I must have looked at it before, but can't think of any time when I would be looking at something like that."

These additional responses show that the subject is prepared to treat his original experience on exposure of the card as a 'feeling'. He does not, however, develop in any detail the status of the response.

The above reaction taken as a whole may be described as an *experimental paramnesia.* It is marked by an obvious element of fabulation.

B 5: Egyptian Girl. "I think I've seen that. In the *National Geographical Magazine* of America or an Egyptian State Railways poster—the colouring is not bright enough for that. It may have been in the *National Geographical Magazine.*" *You think you've seen that before?*—"Yes. It's not one I saw on Monday. I think it's the sort of thing the *National Geographical Magazine* produces. I can't remember reading an article on it, though. I think it must have been in there." *Can you describe your experience at all on presentation of that card?*—"That I'd seen it before. There were two possibilities: First, the poster; secondly, the *National Geographical Magazine.* It's about a couple of years since I read any of their stuff, but I remember their colour photographs—pretty vivid." *You do think you've seen it before?*—"I'm pretty sure I've seen it before." *Would you describe that as a feeling of familiarity?*—"Yes—but not for long. I think I've traced it down fairly completely. I think I've got it. It reminded me of this magazine and the things that have been in there. That knocks out the feeling of familiarity pretty well."

Again we note that the subject at once relates the picture to an acceptable context in his past experience. But this reference again lacks precise localization in place or time. Again, too, rationalization of a wholly constructive character supervenes on the original judgement. We note also that the subject is prepared to accept the expression 'feeling of familiarity' as an adequate description of his experience. He stipulates, however, that this is dispelled as soon as an adequate explanation is forthcoming. Comparable reports are often obtained in descriptions of paramnesia in everyday life.

B 6: Reynolds's "Marquess of Crewe". "Yes, I think so, although I'm probably confusing it with Gainsborough's 'Blue Boy'. It's the style more than anything else I remember." *Can you tell me where or when you saw that?*—"No, I don't think I've actually seen that card: It's similar to Gainsborough's 'Blue Boy'."

This response is harder to interpret. It is noteworthy that the card is not itself recognized, and that the familiarity it elicits is displaced on to a somewhat similar picture. Doubtless the subject was genuinely acquainted with the latter. Perhaps we may speak of *displacement by analogy* as governing the rationalization in this case.

(*b*) *Similar cards.* The similar cards fall into four well-defined groups which may be briefly described:

(1) *Still Life* (α). Three cards, B 3, A 6, and C 8 were all copies of oil-paintings showing dead game and the like.

(2) *Still Life* (β). Two cards, A 4 and C 9, in which fruit and flowers were prominent.

(3) *Prehistoric Flints.* Two groups of two pairs: (α) A 2 and C 6 (Three Flints); (β) B 2 and C 11 (Nine Flints). The resemblance between the two members of each pair was extremely close.

(4) *Church Interiors.* Cards B 4 and C 5 respectively.

We may consider the responses to the members of each of these four groups in their order of presentation on the recognition test.

(1) *Still Life* (α).

B 3*: Still Life.* "I've seen that before. Well, I don't know. I associate it with an old pub. I seem to remember an old blue tankard with a lid. I think it was on a bench. The name 'Oilette' (trade mark) I remember. I don't know: it's probably one of the same series I'm confusing it with."

A 6*: Still Life.* "That's the one I saw on Monday. I don't know. There isn't a gun in it. But there is the shelf and the tankard. I seem to have in mind a composite of the two."

C 8*: Still Life.* "No I haven't...I definitely haven't seen that one. I would have remembered the young deer. I definitely haven't seen that."

It will be seen that the control card, C 8, is definitely rejected. But there is considerable confusion and uncertainty in the other two cases. In the case of the hypnotic session card B 3, the subject is evidently perplexed by the absence of the blue tankard in fact present in the waking session card A 6. In the case of the latter card, moreover, he is equally perplexed by the absence of a gun which had in fact appeared in the card seen when under hypnosis. The position is instructive for two reasons: First, it shows that a hypnotic inhibition can interfere with response to a *waking* session card. Secondly, it suggests that the paramnesia evoked by the hypnotic inhibition is displaced by projection on to a member of the waking series. The whole process here involves both condensation and inter-serial displacement.

(2) *Still Life* (β). Card C 9 was shown as the 17th, and card A 4 as the 21st member of the recognition sequence. There was no confusion of any kind between these two cards. And yet the degree of similarity was no less marked than in the preceding couple.

C 9*: Still Life.* "No, I've never seen that before—nor anything like it. It's the sort of thing I would have remembered as it's got rather exotic colouring."

A 6*: Still Life.* "Yes. That's one of the one's I saw on Monday or Tuesday or whenever it was (the first session). I remember it distinctly by its being laid out on the board—and the straw—and the peculiar poppy or whatever it is."

These two responses provide an excellent illustration of normal differential response to visual material. They contrast sharply with the responses to the preceding pair.

(3) *Prehistoric Flints:* (α) *Three Flints;* (β) *Nine Flints.* We shall quote the reactions to these four cards in their order of sequence on the recognition test.

C 6*: Three Flints.* "That's one I saw on Monday, I think. Not sure....I think the one I saw on Monday had more pebbles in it. It doesn't seem to 'fit', quite."

B 2*: Nine Flints.* "I think that's the one I saw on Monday. That's the one I saw on Monday. I remember counting up to nine. Those (flints) fit better with my naming."

A 2*: Three Flints.* "Oh I've seen that before! I remember the 'wolf's head' sort of thing (outline of one of the flints). Rather like the one I saw on Monday, but I remember counting up to nine. I seem to remember the 'chisel-point' (another flint) on the left. I remember that."

C 11*: Nine Flints.* "No, I haven't seen that one before, although it has got nine. They weren't arranged in that order."

These four responses must necessarily be considered together. The first point to note is the unqualified rejection of one of the new cards, namely, C 11. The second outstanding point is the pronounced confusion between the remaining three cards. The first to be shown, a control card, is at first accepted as having been seen previously, but is later rejected on the ground that the card actually shown had more flints in it. The second, the hypnotic session card, is accepted, *but erroneously referred to the first waking session.* The third card is also identified, but the subject apparently persists with his assertion that the card shown on the first session had nine flints. Such a card was shown during the hypnotic session. Thus the waking session card, though identified correctly, is not referred to its appropriate session whereas the hypnotic session card is rationalized by inter-serial displacement.

(4) *Church Interiors.* This was a case in which a hypnotic session card bore a certain similarity to a control card. The latter was at once rejected, but the former initiated a beautiful paramnesia:

B 4*: Church Interior.* "I've seen that one before. I don't know when and I can't think where I could have been to see it. The peculiar colour of the wood or whatever it is....Normally I only see postcards of cathedrals when I'm at the cathedral concerned, but I can't remember anything like that. Yet the red colour sticks out very definitely." *How would you describe your experience on your first reaction to that card?*—"Rather surprised: I thought it might have been one I saw on Monday, yet the only one connected with a church was one we've had before. Yet I feel fairly sure I've seen it." *On what do you base your verdict?*—"The colour of the card. To say the least it's not normal. It seems that I've seen it before. It may be another type of card with similar colouring." *Have you ever had any experiences in ordinary life similar to that?*—

"Yes, once or twice. Usually turned out to be places I had been to a good many years ago." *Would you describe your experience as one of familiarity?*—"Of familiarity, not of the place, not necessarily of that particular card, but with the red colour applied to wood of some sort. It quite probably would be a church or cathedral."

The above is a clear-cut illustration of experimental visual paramnesia. There is immediate reference to an unspecified locus in past experience. There is considerable confidence in the reality of this past experience. The paramnesia is very specifically localized and restricted to a single aspect of the material. There is evidence that the judgement is based in part on an affective response. Lastly, the subject accepts the analogy of this experience with instances of localized paramnesia in his everyday experience. The tendency to rationalization, however, is less than in some of our earlier cases.

We may now attempt to summarize the principal results given by Subject W in this test as a whole:

(1) Unique cards of the waking session (Series A) were at once recognized and referred to the session during which they were exposed. Unique control cards (Series C) were invariably treated as new and rejected for the purposes of differential response.

(2) The three unique cards of the hypnotic session (Series B) gave rise to responses which may be termed *experimental paramnesia.* A judgement of reference was expressed, but the conditions of previous acquaintance could not be formulated with any degree of definition. This judgement was associated with varying degrees of confidence.

(3) The paramnesia was rationalized spontaneously in two cases on a wholly constructive basis. In one case, the rationalization was compound. These rationalizations are obviously allied to fabulation.

(4) The responses obtained with certain groups of similar cards were comparatively complex. In one case, the subject ran into difficulty both with the hypnotic session card and a somewhat similar member of the original waking session series. The difficulty was partially overcome by a process of condensation with inter-serial displacement.

(5) In a second case, a hypnotic session card was erroneously ascribed to the original waking session. Difficulty was met in accounting for the corresponding waking session card actually shown on this session. This is another example of rationalization by inter-serial displacement.

(6) There is some evidence that the judgements of reference passed on the hypnotic session material are based on an initial reaction of an affective character.

(7) In no case was a connexion suggested between the peculiarities of recognition and the events of hypnosis.

IV. Results with Subject M

Subject M was a young army officer with previous University training. He had studied no psychology. This subject was tested for recognition by an examiner who was himself ignorant of the series to which the individual cards belonged.

(*a*) *Unique Cards: Series C.* The responses given to this group were very full and largely free-associational in content. On no occasion did the subject suggest that he had previously seen the same or a similar picture. We may quote two typical responses to members of this group:

C 1: "*Coming Through the Rye*". "Coming through the Rye reminds me of Scotland—but the picture doesn't remind me of Scotland—Holland—Belgium. I once camped in the stubble by a cornfield...."

C 12: *Rottingdean School.* "I have not seen that before but it reminds me of school. I hope the boys look after their library because it looks rather a good one. I remember, etc...."

Series A. The three unique cards in this series were at once identified and ascribed to the waking session. One example will serve to indicate the character of these responses:

A 3: *Dutch Women.* "Ah! I saw this on Monday. The red roofs I know remind me of Germany...."

Series B. We have now to describe the responses to B 1, B 5, and B 6 respectively:

B 1: *Japanese Print.* "This card makes a great impression on me. I wonder who the lady is? Ghosts. It reminds me of a phrase people sometimes say: 'I am sure you said that before' or 'I am sure I have heard it before' or 'I knew you were going to say that'. It reminds me of symbolism in an archaeological museum or surrealist art. It depresses me a bit that picture...the fan...the lantern...but that lady in the background intrigues me."

This response is interesting in view of the spontaneous reference to descriptions of *déjà vu.* One can readily suspect that the subject was himself experiencing something that could be aptly expressed by a phrase of this kind.

B 5: *Egyptian Girl.* "Where have I seen you before? She is certainly beautiful. What a size is the pot! How far has she to wade into the Nile to fill the pot....The water looks very shallow...."

This response again suggests an element of paramnesia, but it is interesting that the subject makes no attempt to answer the query

which he has himself raised. Probably a few carefully chosen questions would have elicited some interesting reactions. The experimenter, however, was exercising great care in order to avoid influencing the subject by suggestion in any way.

B 6*: Reynolds's "Marquess of Crewe".* "I have seen a picture like that before. Probably in the National Gallery. It's rather grotesque seeing a boy dressed up like that...."

We are unable to interpret the significance of this response. Certainly the picture is not related to the period of hypnosis, but what the subject has to say about it in other respects may well be true. His behaviour is very similar to that of the previous subject.

These three responses lack the elaborate justifications which were found to be so characteristic of Subject W's behaviour when confronted with the unique hypnotic session material. This difference may well depend upon some temperamental factor. In other respects, however, the paramnesias set up are very similar in the two cases.

(*b*) *Similar Cards.* The four groups of similar cards have been described above (p. 38). Our presentation of the results follows that described in connexion with Subject W.

(1) *Still Life* (α).

B 3*: Still Life.* "I have the impression...I have the impression that I have seen that before..." (*pause*). *Do you remember where or anything about it?*—"I have a feeling I should like to tell you, but why can't I say it? I have the same feeling as I had....I know exactly....There is something in my mind which is making continual efforts to tell you but my tongue won't get on with the job. Now where did I? I am just saying to myself now: 'Come on, don't be so dumb! You know you have seen it before!'...It's like making up one's mind to jump over one of those walls that give way under you—those dry walls in Yorkshire—I simply can't give you the answer. It's a very tiring process too."

This is a beautiful example of inhibited recognition. The subject is confident that he has seen the card before, and confident, too, that he knows all about the earlier occasion. Yet he is absolutely unable to formulate, or at least to communicate, the necessary information. It is interesting, too, that M shows considerable insight into his perplexity, and does not attempt to rationalize it in the rather facile manner which we have noted in connexion with the previous subject, W.

A 6*: Still Life.* "I saw this on Monday (the first day of the experiment). There is the old calendar or almanac probably giving remedies for all sorts of ills...."

We note that this waking picture is at once identified and ascribed to the session on which it had been shown.

C 8: *Still Life.* "I have not seen this before. I suppose this fellow was killed for food...probably it is the dull colour of the picture but I don't like it...."

It is interesting to compare the response to B 3 with those given to the other two similar cards. The first is a typical paramnesia of recognition; the other two are typical differential responses to visual material.

(2) *Still Life* (β). There was no trace of confusion between C 9, one of the control cards, and waking session card A 6, despite their similarity in content. The first was treated as an altogether new stimulus; the latter was accepted with the characteristic response: "Yes, I have seen this on Monday."

(3) *Prehistoric Flints:* (α) *Three Flints;* (β) *Nine Flints.* We may quote these responses in their order of sequence:

C 6: *Three Flints.* "That reminds me of a card I saw on Monday. But I am sure it was not the card I saw on Monday because these flints are of a much better shape. They give the impression of being hand-made, etc...."

B 2: *Nine Flints.* "I didn't see that card on Monday but I have seen it somewhere. The flints are not very well-shaped, etc...."

A 2: *Three Flints.* "I saw this on Monday. Here they are—this flint and chalky stone and the central one is so smooth...."

C 11: *Nine Flints.* "I may have seen this before. I...For some reason that picture irritates and worries me because it makes me think that my memory is not so good as it ought to be. If I have seen that picture before, why can't I say where I have seen it? Perhaps because I am no longer interested in those kinds of thing."

This subject experiences no difficulty in discriminating the cards with three flints. But the other pair, those with nine flints, give rise to the paramnesic type of reaction. Both are treated as having a parallel in past experience, but no precise details can be given in either case. If anything, the control card stimulates greater perplexity than the one seen when under hypnosis. The suggestion that the subject fears some deterioration of memory is particularly interesting.

(4) *Church Interiors.* Card C 5 was rejected without hesitation. Card B 4 gave rise to an interesting response probably in line with those which have been described in the other cases.

B 4. "I have a feeling of distaste for that—as though I had been thinking about it for some time....It is rather a gaudy church...."

The interesting point here is the affective reaction to this card, and the explanation which the subject offers for it. It suggests that unpleasant feeling tone may be associated with the hypnotic resistance.

We may now give a brief summary of the results from Subject M:

(1) All unique cards in the C series were treated as new, and all in

the A series as having been seen previously. Normal differential reactions were recorded in all cases.

(2) The three unique cards seen under hypnosis gave rise to recognition of the paramnesic type. In the first case, spontaneous reference was made to common descriptions of *déjà vu*. In the second case, the subject at once asked himself where he had seen the subject of the card before. In the third case, the familiarity initiated by the card appeared to be displaced on to a similar well-known picture.

(3) The hypnotic session member of a group of three similar cards set up an outstanding paramnesia. The other two members of the group were dealt with normally.

(4) In a second group of four similar cards, a new control card was discriminated successfully from a very similar card seen during waking session I before the latter had been exposed.

One seen when under hypnosis was, however, confused with its counterpart in the C series, and both elicited pronounced paramnesias.

(5) Subject W was not given to fabulation of a constructive and facile character. He rationalized to some extent from time to time. In the main, however, he appeared aware of some check in interpreting the test material. He did not adduce any connexion between this difficulty and the events of hypnosis.

V. Results with other subjects

Three other subjects took part in the experiment. In two cases (E and Y), the outcome was unsuccessful, the suggested amnesia did not take effect, and both subjects were able to recall the events of hypnosis.

Subject Y. This subject recognized five of the six *B* series cards and ascribed them correctly to the hypnotic session of the previous day. He incorrectly attributed one of the *A* cards to this session.

B 3*: Still Life.* "Yes, I've seen that before. I think I saw it yesterday."
B 5*: Egyptian Girl.* "Yes, I saw that yesterday."

This subject, when asked later about the events of hypnosis, said: "I can remember being shown some pictures; they seem immediately familiar to-day. I can remember about six pictures." Asked whether he had been given any special instruction in connexion with these pictures, he said: "Well, he (H. B.) said something about not remembering pictures, but when I woke up I couldn't get out of my head what the pictures were: it seemed rather incongruous at the time and I was a little worried about it."

Subject E. Three cards of the hypnotic session were definitely identified by this subject. One was identified but ascribed to the wrong session. Two were thought to have been shown under hypnosis, but the subject was far from certain about this. We may quote four of the responses to these six cards:

B 3*: Still Life.* "Aha! That was not shown to me by you on Monday but by Dr Banister last night...."

B 1*: Japanese Print.* "Um...not sure whether I've seen that one or not. It vaguely suggested one shown by Dr Banister last night."

B 2*: Nine Flints.* "First thing: Have I seen it before or not? May be one Dr Banister showed me. Then the name *six* came into my mind; then the Birmingham Museum."

B 4*: Church Interior.* "Um...registered that I've seen this before but I don't know where. Outside St John's Chapel....I think you showed it to me on Monday."

This subject told us later that he remembered practically everything about the hypnotic session, and had anticipated a recognition test on the third day of the experiment.

Subject P. The results in this case occupy an intermediate position between our two successes and our two failures. This subject was conscious during the recognition test of some vague recollection of having been shown some pictures on the previous day. On the other hand, he was completely amnesic for the odours.

He brought forward his recollection of hypnosis to justify recognition in two cases of response to hypnotic session material. In three cases, however, other more constructive interpretations were forthcoming. All the members of Series A were identified and all the twelve control cards rejected. We may quote his responses to the six hypnotic session cards:

B 3*: Still Life.* (Obvious perplexity.) "That's familiar...it's by the same person who drew the one with the two birds in it and the brass pot." *Did you say it was familiar?*—"I don't know. It's the same type of still life as the other one was."

B 1*: Japanese Print.* "I seem to have seen this one before....I remember the peacock's feather." (Very puzzled.) *Can you describe your experience on first seeing that?*—"I am pretty sure I had seen it—the peacock's feather. I don't know why." *I suppose you've no idea where you might have seen it before?* (Hesitatingly.) "I do remember Dr Banister showing some yesterday."

B 2*: Nine Flints.* "That's vaguely familiar too. I seem to remember the nine flints or whatever they are." *Anything else to say about that one?*—"No."

B 4*: Church Interior.* "Er...I think I remember that. I remember the two battle-flags and the church, and I remember I was struck by the electric bulbs." *Do you think you've seen that before then?*—"I'm pretty sure I have." *Can you tell me anything else about that one? Where you have seen it?*—"I don't think it was one of the six (A cards). It's similar to the one of the chapel, but I definitely hadn't seen that." *But you do think you have seen it before?*—"Yes, I do think I have."

B 5: Egyptian Girl. "I think I remember this one. It's the sort of thing one has seen at Tourist Bureaux." *Anything else about it?*—"No." *You think you've seen it before?*—"It seemed vaguely familiar. I may have seen something like it at Bell's (Tourist Agency)."

B 6: Reynolds's "Marquess of Crewe". "That...that one I seem to remember.... I remember seeing Henry VIII, and I remember the dog biting itself." *You think you've seen it before?*—"Yes, I'm pretty sure." *Where have you seen it, do you think?*—"I don't know, unless Dr Banister can have shown it to me. I can't place it really. I'm not as certain as with those you showed me (Series A)." *Do you remember having seen it before?*—"It's familiar, I think."

These responses are quite in line with those obtained from Subjects M and W, despite the suggestion made in two cases that the cards might have been shown under hypnosis. The inhibition, though less complete than in the first two cases, is nevertheless adequate to cause some perplexity and difficulty in recognition. One may notice the attempted serial displacement with B 3 and the rationalization by analogy with a travel poster in the case of B 5.

VI. Quantitative data

We have summarized in Table 1 the responses given to all three sets of cards by the five subjects on the third day. In col. 1 is given the number of cards in each set which provoked unequivocal judgements of recognition and reference to the correct session. These we may call cases of *normal recognition*. There are two instances of 'false' recognition due to control cards, which were similar to others which had been shown during waking session I, being twice treated as belonging to the A series. In col. 2 we show the total number of cases in which a card was referred to a session other than that on which it had been originally shown. This we have called *inter-serial displacement*. Entries under the heading A denote cards in this series which were displaced to the hypnotic session, and entries under the heading B denote hypnotic session cards displaced

Table 1

	Col. 1 Normal recognition			Col. 2 Inter-serial displacement			Col. 3 Rejection			Col. 4 Experimental paramnesias		
Subject	A	B	C	A	B	C	A	B	C	A	B	C
W	5	—	1*	—	1	—	—	—	11	1	5	—
M	6	—	—	—	—	—	—	1	11	—	5	1
P	6	2	—	—	—	—	—	—	12	—	4	—
Y	4	5	—	2	—	—	—	1	12	—	—	—
E	5	5	1*	—	1	—	1	—	11	—	—	—
Total	26	12	2*	2	2	—	1	2	57	1	14	1

* Incorrectly recognized.

to the waking session. Col. 3 shows the number of cards in each group which were judged as being seen for the first time. We call these *rejections*. Col. 4 gives the total number of cards referred to an unspecified or fabulated context. These we call *experimental paramnesias*.

The total number of recorded paramnesias is sixteen. This represents 13 % of the total responses given by all subjects on the recognition test. Of the total responses given to Series A and B together, 25 % are experimental paramnesias. Of the total responses given to cards shown during the hypnotic session alone, 47 % are paramnesias. If we consider only the responses given by Subjects W, M, and P this figures rises to 78 %.

The mean *reaction times* for Subjects W, M, and P, at the third session, to the A and B sets of cards are given in Table 2. Reaction time, for present purposes, was taken to mean the interval elapsing between presentation of a card and the first verbal response given by the subject.

Table 2

	Reaction times during waking session II to cards seen during			
	Waking session I (A)		Hypnotic session (B)	
Subject	Mean	S.D.	Mean	S.D.
W	2·3	1·1	4·2	2·2
M	7·0	8·3	26·7	12·4
P	2·5	1·8	4·3	1·5

It will be seen that all three subjects show a longer mean reaction time in dealing with the hypnotic session material. The scatter, however, is so large that no definite conclusions can be drawn. It is possible that a repetition of the experiment using more subjects would give a significant difference in reaction time to the cards shown in the waking and hypnotic sessions.

VII. Discussion

Our results clearly show that it is possible to provoke, under experimental conditions, states of consciousness which appear to be the same as normal restricted paramnesia. The greater ease with which these phenomena were elicited in our first two cases is probably due to two main factors: First, the relative depth of hypnosis; second, individual susceptibility to post-hypnotic amnesia. Our first two subjects were hypnotized fairly deeply, and both appeared to be completely amnesic not only for the prohibitions given but also for the greater part of the trance. In the case of E and Y, on the other hand, hypnosis was com-

paratively light, and both subjects were afterwards able to remember a fair amount about the procedure. Both subjects could recall having been shown pictures and told to forget them. It was unfortunate that we were unable to use subjects who on other occasions had shown a marked degree of spontaneous amnesia for hypnotic experiences. We would suggest tentatively that a temperamental factor is involved in addition to mere degree or depth of hypnosis.

The significant point in our results is that paramnesias were so consistently obtained under conditions in which amnesia for the hypnotic session was complete. There were only two cases of out-and-out rejection of cards shown under hypnosis, and in one of these, at least, there was more than a suspicion of the paramnesic type of response. Our results consequently differ from those of Strickler (8) and Claparède (3), both of whom report absolute failure in recognizing items presented in the hypnotic state. Some possible reasons for this divergence at once suggest themselves. In the first place, both Strickler and Claparède used comparatively meaningless material. Our own material, on the other hand, was designed to appeal in some measure to the interests of our subjects. In the second place, these authors may well have induced more profound hypnosis than we did. It seems not altogether unexpected that disconnected and utterly artificial material previously given under deep hypnosis should fail to stimulate even a chord of recognition when given once again in the waking state. All the same, we believe that further work is necessary to account for this discrepancy between the earlier work and our own results.

The experimental paramnesias illustrated in our paper have three fairly well-defined moments: (*a*) an immediate act of reference of the stimulus to an unspecified context in the history of the individual; (*b*) a phase of perplexity, sometimes mildly distressing, and always associated with an effort to formulate this context in more definite terms; (*c*) an act of rationalization often wholly constructive in content. This phase was more prominent in some subjects than in others, and might be entirely lacking.

The judgement of reference was typically conveyed by the statement: "I've seen that before." This judgement almost always carried conviction in the subject's own mind. It is true that doubts might be expressed later on, but this first reaction was generally expressed with considerable confidence. In some cases the judgement appeared to be based on a primary affective reaction to the presented material. But the evidence certainly does not warrant our saying that this was so in every case.

Introspective testimony was seldom given unasked, and all the answers to our special questions are open to the suspicion of suggestive influence. We had extremely few reports of a clear-cut experience of familiarity anticipating the judgement of reference. But the lengthened reaction time in these cases possibly suggests that some such factor plays a part in governing the response.

The phase of perplexity was always associated with difficulty in localizing the previous perception of a card in time and place. Sometimes a rationalization followed so rapidly on the initial statement that this stage did not appear. In the great majority of cases, however, a notable interval elapsed between the first overt reaction and the final acceptance by the subject of the conditions under which he believed the earlier presentation to have taken place. In cases in which no explanation of any kind could be elaborated, the phase of perplexity persisted until the exposure of the next card in the series.

The phase of rationalization cannot be sharply distinguished from the preceding phase, which it always overlaps. The process, we believe, has a two-fold origin: First, it expresses the normal tendency to allot any stimulus initiating an impression of familiarity to an acceptable context in past experience. Secondly, it expresses the subject's attempt to comply with the post-hypnotic suggestion while evading total inability to deal with the presented material. In any concrete case, the process has always as its object the creation of an acceptable and more or less adequate explanation of the somewhat paradoxical familiarity of the material. It is possible, moreover, that a degree of conscious *critique* lower than the normal was in evidence under our special conditions.

We may now pass on to consider in brief the origin and psychology of experimental paramnesia. In the first place, it is important to consider how far our findings are a function of the instructions given under hypnosis. The subjects, it will be remembered, were simply told that they would forget each successive stimulus and be unable to recognize it on the following day. We provided no definition of the term "to recognize", and it was obviously left to the individual subject to interpret the command in the light of whatever idea he might have of its meaning. Now popular connotations of the term 'recognition' are extraordinarily varied. Many people do not habitually include under the term mere impressions of familiarity with vague localization of the stimulus in past experience. It follows, therefore, that our subjects may have understood the suggestions as excluding the possibility of detailed recognition alone. If this were so, the paramnesias would represent mainly those aspects of

the recognition process which had not been made subject to an artificial repression. This ambiguity might have been avoided either by a more precise definition of the terms figuring in the suggestion or by using only subjects who could be relied upon to display spontaneous amnesia for the events of hypnosis. In the latter case, special instructions would not of course be needed. It is hoped one or both of these precautions will be taken in any future work along these lines.

A second possibility is that the paramnesias evoked by our material truly represent the activity of cognitive mechanisms outside consciousness. Such an assumption is of course implied in MacCurdy's theory of *déjà vu* (5, 6, 7). MacCurdy holds that every act of recognition depends on the arousal of a co-conscious image similar in content to the present stimulus. Normally, this image is recalled into consciousness and furnishes a basis for comparison. Should it be repressed, however, through any cause, it can influence consciousness solely through the medium of affect. Thus arises the so-called feeling of familiarity. On this view, then, restricted paramnesias are due to the repression of material necessary for full recognition of any stimulus. Certainly our results could be predicted from MacCurdy's theory.

The resistance to recognition, artificially induced in our experiments, is of course closely akin to the process of repression which MacCurdy and other authors have in mind in explaining paramnesia. On the other hand, we do not ourselves believe that a pre-existing repression is necessary always for the appearance of paramnesia in daily life. In some cases, simple obliviscence seems a sufficient explanation. In other cases, the appearance of an object in an unwonted context, with difficulty in formulating the habitual context, provides a sufficient condition. What is essential is not repression as such, but any condition impeding access to the requisite memory material.

Lastly, do our experimental paramnesias throw any light on the origin of *déjà vu*? Those, who believe with MacCurdy that *déjà vu* represents a method of rationalizing paramnesia, might expect to find a certain number of our experimental paramnesias setting up further rationalizations along these lines. But in no case did we find a paramnesia rationalized in the sense of *déjà vu*. This evidence then, for what it is worth, fails to provide support for the psychoanalytic view. It may be that further experiments will enable us to duplicate also experiences of *déjà vu* under experimental conditions. But the existing results cannot be said to throw light on paramnesia in its more generalized forms.

VIII. SUMMARY

1. Illustrations are given of restricted paramnesias set up in response to material for which post-hypnotic amnesia had been induced. These responses are strikingly similar to paramnesia in daily life.

2. Three moments can usually be distinguished in the paramnesic response: (*a*) An initial judgement of reference to the past; (*b*) a phase of perplexity marking an effort of recall; (*c*) an act of rationalization often wholly constructive in character.

3. Rationalization took various forms. One of the most common was a projection of the paramnesia on to material previously seen in the waking state. A special form of this we have called inter-serial displacement. Fabulation was prominent in the responses of one subject.

4. The psychology of experimental paramnesia is briefly discussed. It is pointed out that our results might depend, in part at least, on the character of the prohibition given in hypnosis.

5. Our results provide some evidence in support of MacCurdy's theory of paramnesia. But they throw little light on the origin of *déjà vu*.

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THE EFFECT OF ALCOHOL ON THE CENTRAL NERVOUS SYSTEM[1]

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I. *Introduction* (p. 52)
II. *Description of experiments* (pp. 53–54)
III. *Results* (pp. 54–60)
IV. *Summary and conclusions* (pp. 60–61)

I. Introduction

It is generally recognized that the effect of a given dose of alcohol on the central nervous system may vary widely from one individual to another, and also in the same individual on different occasions. Some of the factors responsible for this variation are known empirically: e.g. the dose is less effective if taken after a meal than on an empty stomach; it is more effective if taken in concentrated than in weak solution. In such cases as these, the greater effect on the nervous system is correlated with more rapid absorption of the alcohol, and it is generally assumed that the greater effect produced by such rapid absorption is due to a resulting higher concentration of alcohol in the blood than that which follows slow absorption.

In experimental work, these variable factors are eliminated as far as possible; a standard dose of alcohol is given on an empty stomach and a standard concentration is used. This treatment is applied to as large a number of subjects as possible, the psychological test is applied at a standard time after the alcohol has been taken, and the average performance of the group assessed. A more detailed study of the relationship between blood alcohol concentration and the reaction of the central nervous system on a small number of subjects has indicated that such average results can have little meaning, and that the variable factors in each individual must be taken into account if his reaction to a given dose of alcohol is to be truly recorded.

[1] The work was aided in its initial stages by a grant from the Rockefeller Foundation to the Maudsley Mental Hospital.

II. Description of experiments

Details of the methods employed for determination of alcohol concentration in blood and urine will be given elsewhere. Blood obtained from a finger prick sufficed for the alcohol analysis, and the shape of the blood-alcohol concentration curve was often amplified from analyses of the urine-alcohol concentration. The urine-alcohol concentration curve runs parallel with and about 30 % above the blood-alcohol concentration curve except during very rapid changes in alcohol concentration.

Tests of central nervous system activity. With one subject (E), on whom the majority of the experiments were performed, three tests were used; typewriting, dotting machine and 'distraction machine'. On three other subjects, only the two last tests were used.

Typewriting. A somewhat difficult passage, involving several inverted commas, etc., was chosen. The passage was always at hand for reference even when it was known by heart. Learning was slower than in the other tests; a time of 3 min. was only reduced to 2 min. 20 sec. after 2 months of almost daily practice. Thereafter, it provided a steadier base line than the other tests, varying only between 2 min. 20 sec. and 2 min. 17 sec. from day to day. In assessing the performance under the influence of alcohol, 1 error was counted as 3 sec.

Dotting machine. Learning was rapid in all four subjects. Two of the four (A and E) then showed a relatively steady performance from day to day. With the instrument moving its fastest speed, the number of correct hits recorded by A was $321 \pm 2\frac{1}{2}$ in his last eight consecutive tests, and by E 295 ± 3 in her last six tests. Subject C learnt slowly and remained rather erratic, 272 ± 8 in his last seven tests. Subject H showed no learning curve but remained erratic; his first six tests gave results of 253–276 (average 262 ± 4), but on the next experimental day he scored 283, and on recovering from the effects of alcohol, showed a score of 311.

'*Distraction machine.*' The general principle of this machine was as follows. A spot of light was made to oscillate, in predetermined, random fashion, about a central position on a scale. The position of this spot could also be adjusted by the subject, by the rotation of a knobbed wheel. He was instructed to endeavour to compensate the random oscillations as completely as possible, so as to maintain the spot of light at its central position. The time integral of the magnitude of the deviation from the central position for the whole period of the test ($1\frac{1}{2}$ min.) was obtained automatically, and recorded on smoked paper. This record was a measure of the success with which the subject was able to follow, and correct, the random oscillations. Small imperfections in the apparatus resulted in the total uncorrected deviation of the spot varying slightly from time to time. Immediately after each test, therefore, the time integral of the uncorrected deviations was recorded, and the total deviation observed during the subject's test was expressed as a fraction of this uncorrected deviation. The better the performance, therefore, the lower the score; i.e. perfect correction = zero, no correction = 1.

At irregular intervals during the course of the test (and varying in relation to each other with each test) red, green and yellow lights were displayed and a buzzing

noise was made. While still manipulating the knob controlling the moving spot of light with his right hand, the subject had to respond to the buzzer by pressing a button with his left hand, and to the red light by pressing a lever with his foot, ignoring the green and yellow lights. Signals recording on the drum indicated whether the correct response had been made.

No attempt was made to compare accurately the performance with and without distractions, but in the early stage of learning, distractions appeared to reduce the performance by about 50 % (three tests, subject E). Thereafter the machine was used only in conjunction with the distractions, but it was noted that additional distractions, e.g. onlookers, a desire to cough, an uncomfortable position in the chair, etc., invariably worsened the performance.

Learning was a considerably longer process than in the case of the dotting machine. The differences noted in the learning and performance of the different subjects with the dotting machine were reflected to some extent on their performances on this instrument. Subject A learnt quickly and remained steady. His score dropped from 0·39 to 0·335 on the first day (four tests) and remained steady between 0·31 and 0·33 during the successive eight test days. Subject H was even more erratic than with the dotting machine; after starting at 0·37, he dropped to 0·315 on the 4th test day, but rose again to 0·36 on the 5th–7th days. On the 8th and 9th he varied between 0·29 and 0·32. It was learnt afterwards that he had been emotionally upset during the 5th–7th day period. Subject C learnt slowly, but ended by attaining a higher performance than Subject A, in contrast to their relative performances on the dotting machine. He settled down to a value of 0·27–0·285. No record was kept of the learning of Subject E, for she had practice during the building of the machine; a score of 0·27–0·28 was regularly obtained when accurate scoring was begun.

If small effects of alcohol are to be detected, therefore, it would seem essential to give time to the preliminary learning of the tests. If only gross changes are being investigated, this could possibly be ignored.

III. Results

The degree of disturbance of the central nervous system produced by a given dose of alcohol depends on three main factors: (1) the weight of tissue in which the alcohol is distributed, (2) the length of time between administration of the alcohol and application of the test, and (3) the susceptibility of the nervous tissue to alcohol. The wide, and only partially recognized, variations in these three in different individuals nullify any attempt to standardize them.

(1) Apart from the large differences in actual weight of different people, alcohol is more widely distributed in some than in others, since it is present in only small quantity in fatty tissue. Thus, of two individuals of the same weight, but different shape, given the same dose of alcohol, the short fat one will show a higher concentration of blood alcohol than the lean muscular one, since the alcohol is distributed in a

smaller weight of tissue. A 40–50 % difference due to this cause may be met in extreme cases.

(2) The inadequacy of using a standard time interval between dose and test is due to the fact that the central nervous system is affected not only by the absolute concentration of alcohol in the blood but by the rate and direction of its change. The observations on which this statement is based are too scattered to permit the formulation of any law

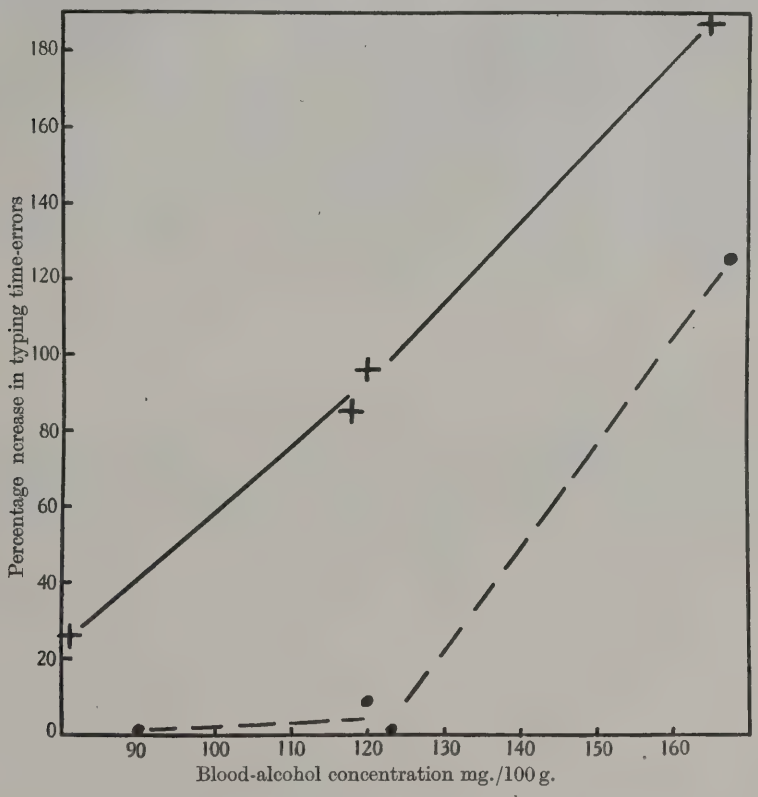

Fig. 1. The effect of blood-alcohol concentration on typing time-errors.
+———+ concentration increasing. ●------● concentration decreasing.

relating such rate of change to degree of disturbance of the nervous system, but illustrations of the different effects observed serve to show the order of magnitude of the relationship.

The dependence of central nervous system disturbance on the absolute value of blood-alcohol concentration is shown, more or less quantitatively, in Fig. 1, and with it the effect of increasing and decreasing concentration. The experiments were all performed on the

same subject. With increasing concentration the typing time-errors were practically doubled at a concentration of 120 mg./100 g. blood, but at this same concentration recovery was almost complete when the concentration was decreasing.

Fig. 2 shows the effect of *rate of increase* in blood-alcohol concentration on the performance with the Distraction Machine in one subject. At the same absolute concentration (100 mg./100 g. blood) an increase in errors of only 13 % was observed on a slow-rising blood-alcohol curve compared with a 70 % increase on a very fast-rising one.

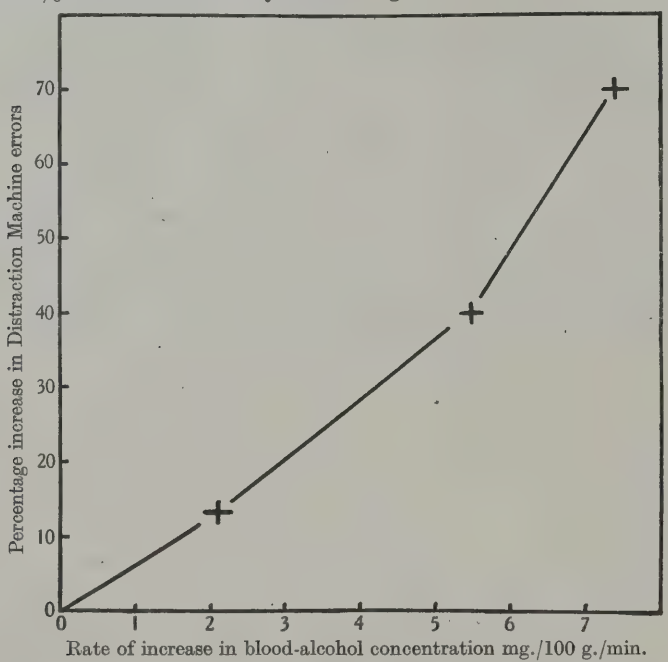

Fig. 2. The effect of *rate* of increase in blood-alcohol concentration on Distraction Machine errors. All three tests were made at an absolute concentration of 100 mg./100 g.

This effect is illustrated from another point of view in Fig. 3, which shows the relationship between absolute blood-alcohol concentration and its rate of increase for a given degree of central nervous system disturbance. This was not quite constant, but the least disturbance (65 % increase in typing time-errors) occurred at a concentration of 180 mg./100 g. blood on a slow-rising blood-alcohol curve and the greatest (90 % increase) at only 115 mg./100 g. blood on a fast-rising curve.

Information regarding the effect of rate of decrease in blood-alcohol concentration is less decisive, for this rate has not varied within wide

limits in different experiments. The phenomenon illustrated in Fig. 4, however, has been met several times and suggests that a high rate of decrease is accompanied by more rapid recovery of the nervous system than is a low rate. If, for any reason, there is a delay in the rate of dis-

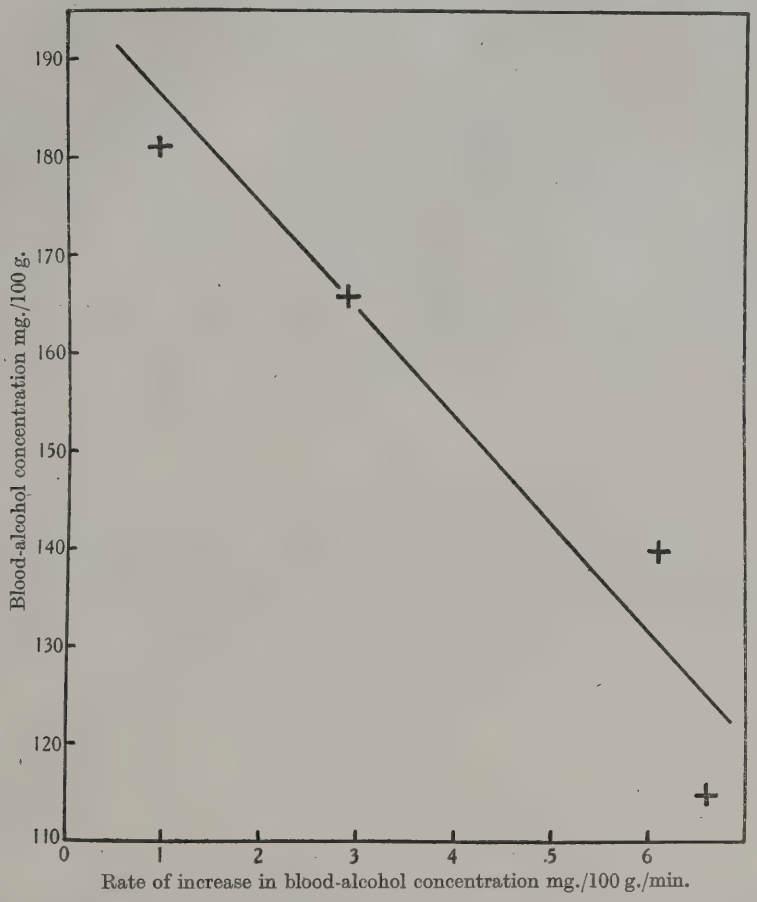

Fig. 3. The relationship between rate of increase of blood-alcohol concentration and the concentration at which a given deterioration in performance (65–90 % increase in typing time-errors) occurs.

appearance of alcohol from the blood stream, the recovery of the central nervous system is interrupted as indicated by the test performance. The effect of increasing compared with decreasing blood-alcohol concentration can also be seen in this figure. An increase in errors on the Distraction Machine of 50 % at about 110 mg./100 g. on the rising blood-alcohol curve is reduced to 20 % at the same concentration on the falling curve.

One obviously important factor in controlling the regularity of change in blood-alcohol concentration is the behaviour of the stomach. The retardation of recovery shown in Fig. 4 was probably due to the extrusion of a small quantity of alcohol left behind in the stomach, followed by its rapid absorption in the small intestine.

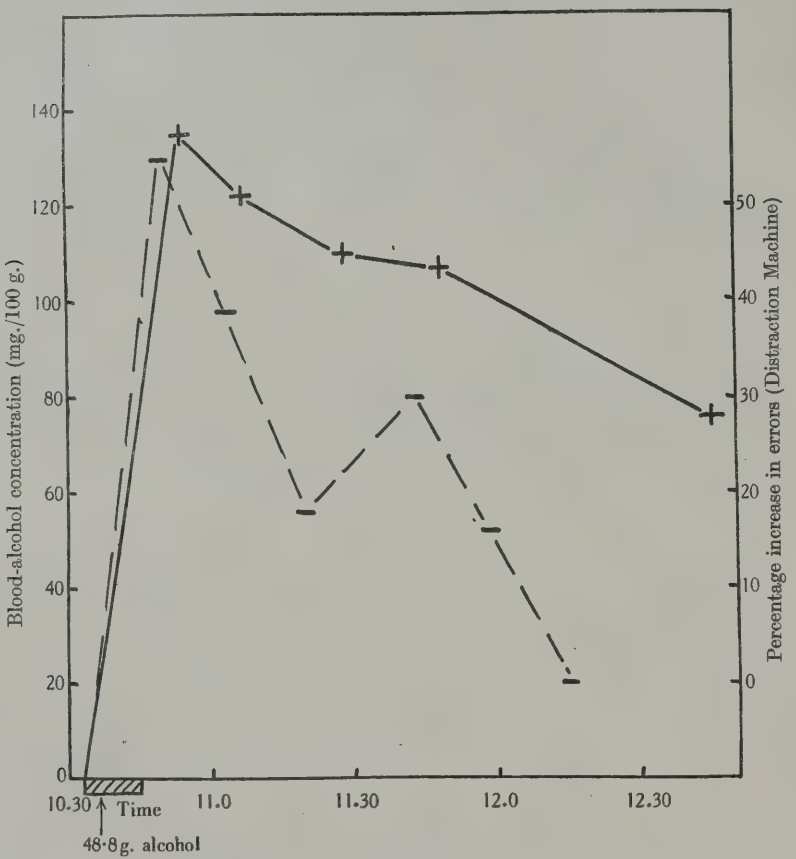

Fig. 4. Comparison of performance on Distraction Machine with blood-alcohol concentration, showing the interruption in recovery accompanying a diminution in the rate of decrease in blood-alcohol concentration. +————+ blood-alcohol concentration. ———— percentage increase in Distraction Machine errors.

The effect shown in Fig. 5 is undoubtedly due to the same cause and has also been met several times. It can be produced in still more pronounced fashion by giving the drink ice-cold. Recovery of the central nervous system as indicated by typing time-errors was almost complete as the blood-alcohol concentration fell to 116 mg./100 g., although a

35 % increase in errors had been observed at a concentration of only 80 mg./100 g. on the rising curve. As the blood-alcohol concentration rose again, an increase of over 50 % in time-errors occurred at 135 mg./100 g.; at 120 mg./100 g. recovery was again complete.

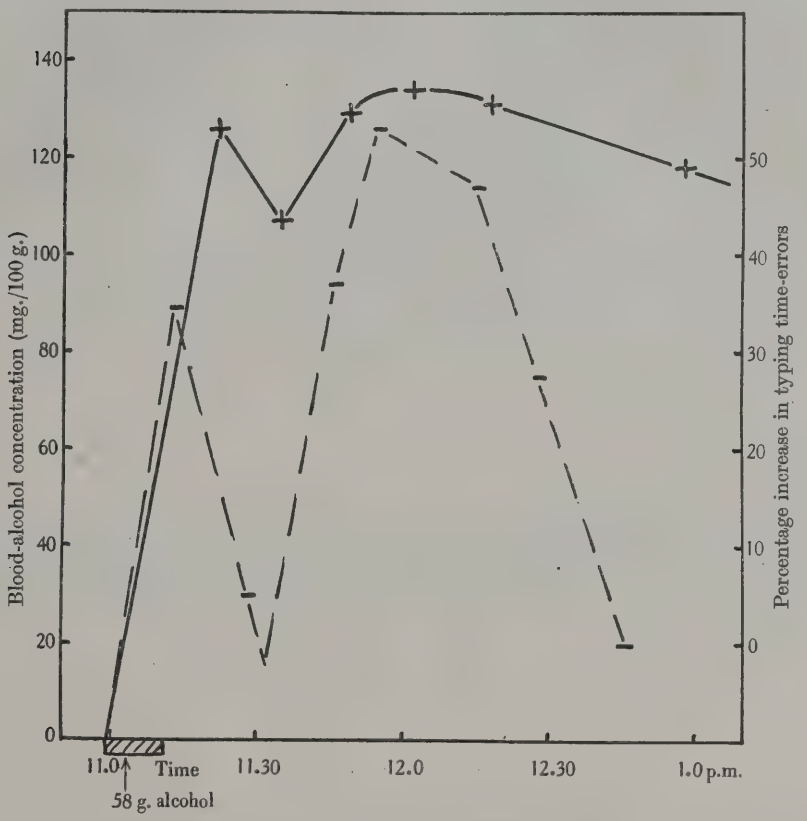

Fig. 5. The relationship of performance in typing test to changing blood-alcohol concentration, showing the greater effect on the central nervous system of a given blood-alcohol concentration when this is increasing than when it is decreasing. +——+ blood-alcohol concentration. ———— percentage increase in typing time-errors

These last two figures illustrate well the main point under discussion. Had the test been performed in each case 30 min. after the alcohol was administered, the larger dose shown in Fig. 5 would have, apparently, produced no deleterious effect on the nervous system, and the smaller dose shown in Fig. 4 a quite marked effect (30–40 % increase in errors). In neither case would the test have indicated the maximum effect produced by that dose on the nervous system. When tests are made for

the purpose of assessing the effects of alcohol on a given individual, therefore, particularly if the result is of practical importance, it would seem advisable to apply the test at least every 10 min. for the first hour following the dose, or until recovery is complete. The subject will in many cases know his own limitations even though he has no knowledge of the blood-alcohol concentration curve: e.g. the habitually rapid absorber may normally take his drink a good half-hour before starting on his work.

The subject from which the records shown in these figures were taken was naturally a fast absorber, the fastest of the four subjects used. In general, each subject appeared to have a natural rate of absorption, and the comparison of various rates was more easily made on the naturally fast one, since absorption can be more readily slowed than hastened. It seems clear that one important factor in the varying tolerance of different individuals to the same dose of alcohol is their normal differing rate of absorption.

(3) To what extent the central nervous system of different individuals may vary in resistance to a given concentration at a given rate of increase is not known. It is, however, a matter of common belief that such is the case, but accurate comparison has not been possible in the series of experiments reported here. Similarly, no accurate evidence is available as to whether this difference in individual resistance of the central nervous system to alcohol, if it exists, is inborn or acquired by frequent usage of alcohol.

IV. Summary and conclusions

It has been shown that the degree of disturbance of central nervous system function, as indicated by performance on typewriter, dotting machine and Distraction Machine, is affected not only by the absolute concentration of alcohol but also by the rate and direction of its change. This statement is based on the following sets of observations:

(1) At any given concentration of blood alcohol, the nervous disturbance is greater if this concentration is increasing than if it is decreasing.

(2) The degree of nervous disturbance at any given blood-alcohol concentration increases with the rate at which this concentration is increasing.

(3) The rapid recovery of the nervous system accompanying a decrease in blood-alcohol concentration is impeded if the rate of decrease is reduced.

The application of a single test at a given time after a dose of alcohol is, therefore, not likely to yield accurate information as to the magnitude of its effect in that subject. It is suggested that a test repeated every 10 min. during the hour following the dose of alcohol, or until recovery is complete, is advisable in all cases where the result is of practical importance.

The Distraction Machine was made for me by L. E. Bayliss, to whom I am also indebted for his constant help and interest in the work.

(*Manuscript received* 18 *January* 1941)

THE NATURE OF DARK ADAPTATION

By K. J. W. CRAIK and M. D. VERNON

From the Psychological Laboratory, Cambridge

PART I. EVIDENCE AS TO THE LOCUS OF THE PROCESS

I. *Introduction* (pp. 62–63)
II. *Description of apparatus* (pp. 63–65)
(1) *Requirements of apparatus* (pp. 63–64)
(2) *Details of apparatus* (pp. 64–65)
(3) *Calibration* (p. 65)
III. *Procedure and results* (pp. 65–69)
IV. *Discussion* (pp. 69–70)
V. *Summary* (pp. 70–71)

I. Introduction

Visual adaptation is the reduction in absolute sensitivity of the eye which occurs during and remains immediately after stimulation by a bright light, and the increase in sensitivity which occurs in the dark. The dark adaptation curve has been shown by Kohlrausch (1922) to consist of two portions, the first representing cone and the second rod adaptation; the first is characterized by perception of colour at the threshold (cf. Hecht, 1921; Hecht, Haig & Chase, 1937) and fairly good acuity; the second by an increase in rate of adaptation as the rods begin to operate, but very low acuity and absence of colour-vision. It has been shown (Craik, 1938) that the eye, when adapted to a certain illumination, responds to changes of illumination over a range of illuminations a thousand times greater or less than this adapting intensity, and that adaptation shifts this instantaneous range up or down the scale of physical illuminations. Thus adaptation is a form of automatic 'range-setting' on the part of the eye which enables it to respond most sensitively to changes in the illumination to which it has become adapted.

It is important to decide where this process of adaptation occurs. There is much physiological evidence that such an effect is shown by the isolated eye and optic nerve (e.g. Hartline & Graham, 1932; Hartline, 1938) and that the concentration of visual purple in the retina is reduced by intense illumination (e.g. Kühne, 1879) and probably accounts for the reduction in sensitivity. However, the electrophysiological or photo-

chemical measurements of adaptation cannot be correlated exactly with its sensory effects, and some minor anomalies arise (Granit, Munsterhjelm & Zewi, 1939). In addition, Brown & Page (1939) have suggested that the initial or cone portion of the dark adaptation curve has a cortical origin and many psychologists have shared the same view on account of the complicated oscillations and inhibitory phenomena which negative after-images or bright adapted areas of the retina sometimes show. Thus some more direct proof of the retinal or cortical origin of the adaptive process seems desirable.

Helmholtz (1924, p. 7) was aware that moderate pressure on the eyeball causes temporary blindness, and quotes Donders as having shown ophthalmoscopically that pulsation and emptying of the retinal blood vessels occurs under these conditions. This has been confirmed by Duke-Elder (1926). This blindness affords a convenient method of blocking the transmission of nerve impulses between the eye and brain. It probably acts by producing retinal anoxia and failure of excitation or transmission in the retinal nerve endings. The bright and dark adaptation of the human eye thus isolated from the cortical visual centres during a period of darkness, during exposure to bright light, or during the immediately succeeding period have therefore been investigated by studying the sensory response immediately after it has returned on releasing the pressure.

II. Description of apparatus

(1) *Requirements of apparatus*

Any dark adaptation apparatus must consist of two parts, the system for bright adapting the subject in order to annul the effects of previous light or darkness and the system for measuring the absolute threshold. A 'Maxwellian view' (see Craik, 1939*a*, p. 253) permits high bright-adapting illuminations to be produced over a fairly large field from a conveniently small light source. It also produces less heat and discomfort than a screen lighted by powerful lamps. The image cast on the pupil of the eye can also be used as an artificial pupil and permits a larger angular diameter of field than is possible with the usual type of artificial pupil-stop placed before the eye. The testing field must be rapidly substituted for the bright adapting one, preferably without movement on the part of the subject whose head should be fixed in a rest. The test field should be 10° or so in diameter and should be capable of being made smaller and of varying in brightness from 10^{-6} e.f.c. upwards to about 1 e.f.c. without marked alteration in its spectral composition. A reducing

device having a logarithmic scale is an advantage. A convenient method of recording the illuminations which are just visible to the subject at each moment is also required.

(2) *Details of apparatus*

A 100 W. 200 V. projection bulb *a* (Fig. 1) is mounted in a ventilated metal box *b*. It illuminates a ground glass diffusing plate *c* through a calorex filter *d*, the area being governed by the aperture stop *e*. Condenser lenses *f* and *g* of 2·5 cm. focus, placed 30 cm. from the diffusing glass cast an image of the stop *e* 2·2 mm. in diameter on the subject's pupils at *h* and *i*. He sees a field 56° in diameter having a brightness of 30,000 e.f.c. as seen through a 2·2 mm. pupil. A blackened gauze at *j* reduces this to 12,000 e.f.c. The right-hand eye-lens is moved in a curved slide by a micrometer screw *k* to allow for variations in inter-ocular distance. The box *b* is suspended by a system of links *l* like those on a parallel ruler and remains in the up or down position by being

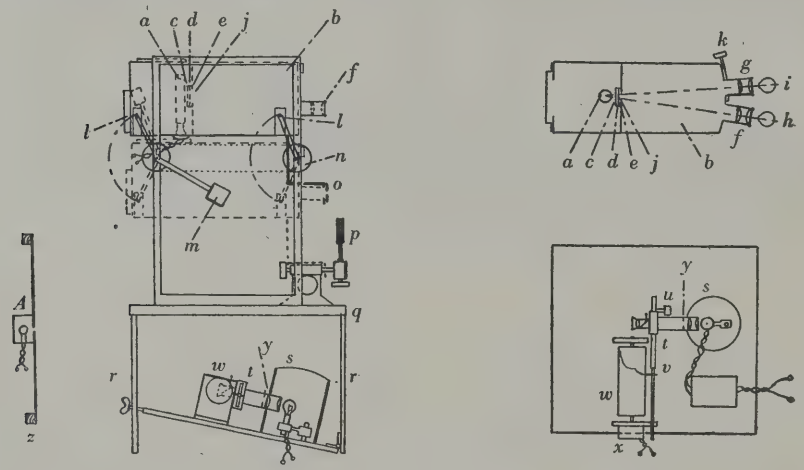

Fig. 1. Diagram of apparatus. For description see text.

counterweighted at *m*. Chains *n* co-ordinate the movements of the links near the point of dead-centre. Artificial pupils are placed at *o* so that they coincide in height and position with the pupil-images of the bright adapting system when the box is raised; these artificial pupils can be moved out of the way and the right-hand one is adjustable for inter-ocular distance. A chin rest *p* adjustable in three dimensions by means of a lathe slide-rest is fixed to the base *q*; wax impressions of the subject's teeth can be fitted instead. An adjustable cradle *r* slung from the base-board carries the projection system for the test field. This consists of a lantern *s* with a 3 W. 6 V. car side-light bulb, condenser, and objective in focusing mount. A neutral gelatine wedge covering 6 log units of density is held in a brass frame *t* near the objective and operated by a rack and pinion *u*. A rod on the end of the sliding frame carries a thin soft pencil lead sprung in a tube *v* which records the position of the filter continuously on a paper

clipped on the drum w driven by a synchronous electric clock movement x so that it makes one revolution in an hour. The size of the field is determined by a stop placed at y; its diameter was 10° without, and 6° with the stop. The lantern illuminates a screen z of matt white card placed 1 m. from the objective. At its centre is a fixation point consisting of a pinhole behind which is placed a 1 W. 4 V. bulb A controlled in brightness by a resistance. This lamp and that in the test-field lantern are fed by bell-transformers.

(3) *Calibration*

The maximum illumination on the screen was measured by a Ritchie wedge photometer and by a Holophane lumeter and was found to be 0·27 f.c. after correction for the reflection factor of the screen. The brightness was 0·22 e.f.c. as viewed through a 2·2 mm. pupil. The bright adapting fields were calibrated by measuring the total energy in the pupil-image by a generator type selenium oxide photocell and micro-ammeter. This reading was then duplicated by illuminating an opal glass screen of known transmitting properties by a 600 c.p. projector lamp with a calorex filter interposed, the light falling on the cell being limited by a 2·2 mm. artificial pupil. The illumination on the opal screen was calculated from the distance of the projector bulb. For checking purposes a photocell with a mount enabling it to be clipped to the lantern or bright adapting eyepieces was made; this gave a standard reading which could be verified on subsequent occasions. The test and bright adapt illuminations were subject to a maximum variation of $\pm 10\%$, owing to mains voltage fluctuations; this is not serious in comparison with the variability of visual thresholds.

For applying pressure to the eye an instrument resembling a tonometer or spring balance was used. A light plunger having a sponge rubber plug 1 cm. sq. in its end moved against a spring in an outer tube. Two springs, one giving a range of 0–250 g. per sq. cm. and the other 0–700 g. per sq. cm. were used and the apparatus calibrated with weights. Tonometers do not indicate intra-ocular pressure accurately, owing to the relatively large influence of the stiffness of the cornea or sclerotic. A calibration in mm. Hg, accurate to ± 10 mm., was secured by applying the instrument to the eye of a freshly killed cat, into which a cannula had been inserted and connected to a mercury manometer. While each pressure was applied the manometer was adjusted so that the volume of fluid in the eye was constant, and the height of the column of mercury recorded. The range covered (from 35 to 225 mm. Hg) may be compared with the normal intra-ocular pressure (about 25 mm. Hg) and the ocular blood pressure (about 27 mm. Hg with a pulse amplitude of only 2 mm. Hg).

On the human subjects any required pressure could be applied and maintained with an accuracy of ± 10 g. by grasping the instrument with the first finger in the appropriate position on the tube and pressing until the pointer on the instrument just touched this finger. To avoid damage to the sclerotic the pressure was applied through the upper lid near the outer canthus.

III. Procedure and results

In order to take a dark adaptation curve the subject was seated in front of the apparatus and the chin rest and artificial pupils adjusted so that he could see the test field with both eyes, this field and the fixation

point being both at their maximum brightness. The bright adapting apparatus was then lowered into position and the right eye-piece adjusted until both eyes when opened in turn saw a uniformly bright field. The field was then fixated for 3 min., this period being found experimentally to produce complete adaptation to any illumination.[1] The bright adapting apparatus was then moved up and the light turned off, the clock switched on, and the subject, in accordance with instructions given beforehand, moved the knob controlling the filter wedge so as to keep the test-field just visible. He also reduced the fixation point brightness with his other hand till it was just bright enough to indicate the position of the test field. (It was found that if the fixation point, in the latter stages of adaptation, was 100 or 10,000 times as bright as necessary a 50-fold or 100-fold rise in threshold was produced by its glare effect.) A continuous record of the logarithm of the threshold illumination against time was thus obtained for the succeeding 55 min. One subject was used, with some confirmatory readings on a second. Three experiments with pressure were performed:

(1) The time of onset of blindness produced by pressure alone and the recovery time on release of pressure were determined with a stop-watch.

(2) The eye was fully dark adapted, then bright adapted for 3 min. at 12,000 e.f.c. while completely blinded by a pressure of 250 gm. per sq. cm. and a dark adaptation curve taken after releasing the pressure.[2]

(3) The eye was bright adapted in the normal way, then a pressure of 400 gm. per sq. cm. was applied for $3\frac{3}{4}$ min. (it was thought that a longer period might cause injury) and a dark adaptation curve obtained immediately afterwards.

The curves relating pressure and time of onset of blindness or 'disappearance time' (Fig. 2) resemble rectangular hyperbolas which are shifted along the time axis with variation in the illumination employed. The actual values of the times obtained are given in Table 1. For any given illumination there is a certain minimum time below which no pressure however great causes a reduction in the disappearance time and

[1] It was found that, provided this condition was observed, daily variations in the dark adaptation curve did not exceed a range of 0·2 log unit.

[2] Difficulty was experienced in keeping the eye opposite the pupil-image of the bright adapting apparatus when it was displaced sideways and blinded by pressure. This was overcome by aligning the head so that the bright adapting field, reduced to 1 e.f.c. by a series resistance, was clearly seen with pressure applied. Blindness commenced after about 10 sec. When 30 sec. had elapsed and the eye was blind even to the highest intensities the series resistance was cut out and the 3 min. bright adaptation given. The bright adapting effect of the 10 sec. exposure to 1 e.f.c. is negligible in comparison with the effect of 12,000 e.f.c., as will be shown in Part III of the present series.

a certain minimum pressure below which no blindness is caused however long the pressure is maintained. With small fields (e.g. about 10°) eye-movements result in a marked return of vision and almost exactly double the disappearance times.

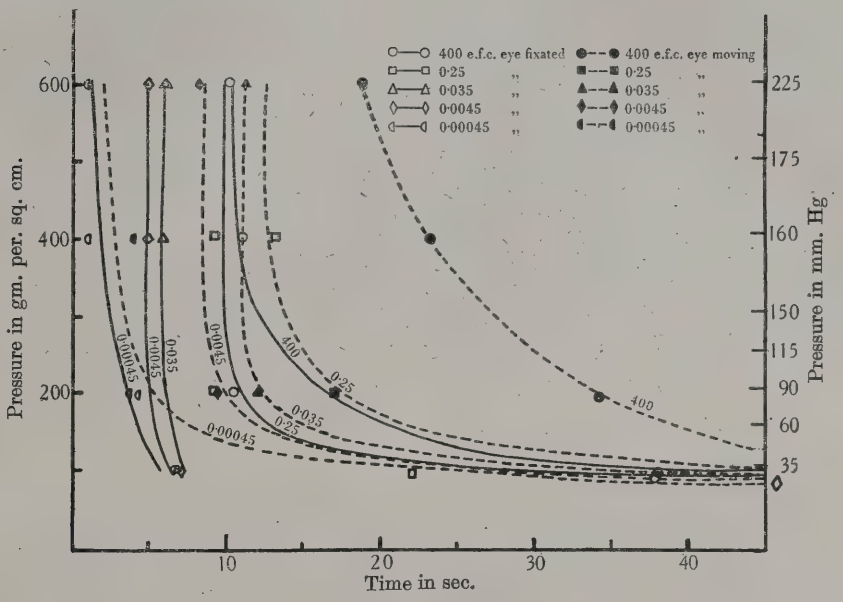

Fig. 2. Relation between pressure applied to the eye and disappearance time for different illuminations, for fixed (solid line) and moving vision (dotted line).

The recovery of vision on releasing pressure is considerable in 5 sec. and complete (as measured by return to the previous value of the dark-adapted threshold) in 3 min., as shown in Fig. 3.

Table 1

Brightness of test patch in f.c.	Extinction time for fixated eye at pressure (in mm. of Hg)				Extinction time for moving eye at pressure (in mm. of Hg)			
	225	160	80	35	225	160	80	35
400	10	11	10½	38	18½	23	34	—
0·25	10	9	9	22	(20)	13	17	62
0·035	6	6	5	7	11	11	12	48
0·0045	5	5	4	6	8	9	9	47
0·00045	1	1	4	6	1	4	4	54

When the eye had been blind during bright adaptation the dark adaptation curve obtained on release of pressure differed in no way from normal except for the slight initial delay attributable to the recovery from the pressure itself (Fig. 4).

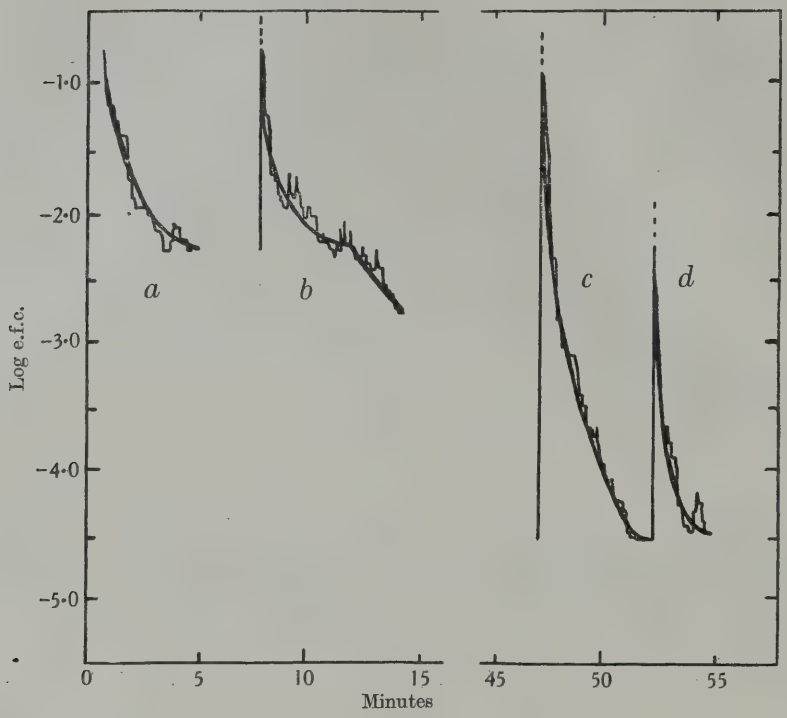

Fig. 3. Recovery of vision after pressure alone: curve *b*, recovery on flat portion of cone adaptation curve (*a*) after 3 min. pressure. Curves *c* and *d*, recovery on flat portion of rod curve after 1½ and 1 min. pressure respectively. In these and subsequent figures the jagged lines are the actual excursions of the recording pencil.

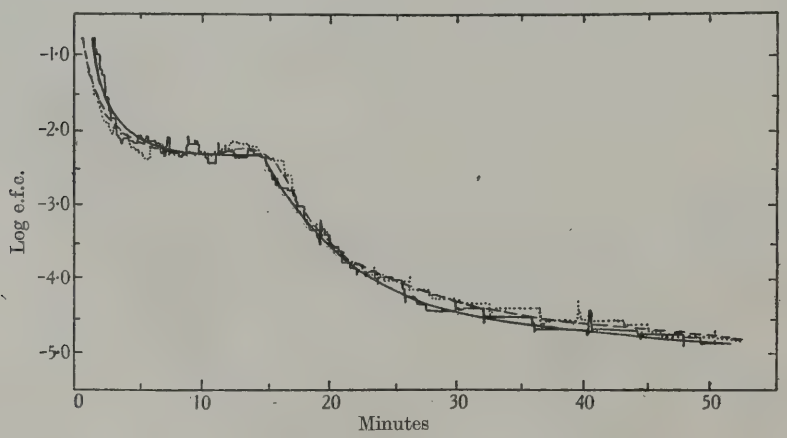

Fig. 4. Solid line—dark adaptation curve when eye had been blind during bright adaptation period; broken line—normal dark adaptation curve for comparison.

When the eye was exposed to pressure for $3\frac{3}{4}$ min. immediately after normal bright adaptation the rod and cone portions of the curve were not delayed (Fig. 5). There is an apparent lag in cone adaptation, but this is explicable as a recovery of the neural system concerned from the pressure itself, with the time course of which it agrees (cf. Fig. 3).

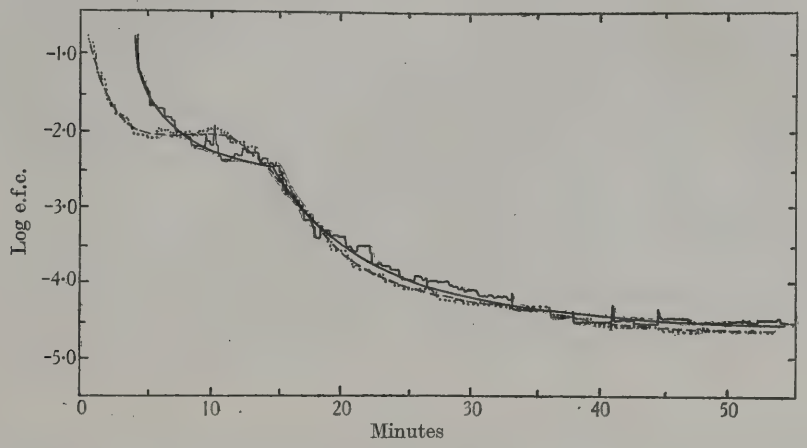

Fig. 5. Solid line—dark adaptation curve when eye had been pressed for first $3\frac{3}{4}$ min. after normal bright adaptation; broken line—normal dark adaptation curve for comparison.

IV. Discussion

The curves showing the relation between pressure and disappearance time for various illuminations indicate that pressure causes a rise in threshold which commences after 5–15 sec. and increases for 30 or 40 sec. Waite, Derby & Kirk (1925) found a rise in the absolute threshold in established glaucoma, which may be partly due to the same action of the raised intra-ocular pressure. Ophthalmoscopic observations of the pulsation and emptying of the retinal arteries caused by pressure were also made in the present investigation. The simplest explanation of the blindness is that the stoppage of circulation produces retinal anoxia and nerve-block, probably in the ganglionic layers. The effect cannot be photochemical since pressure alone does not reduce the photochemical sensitivity of the retina; the recovery of dark adapted sensitivity in 3 min. after release of pressure, as compared with the 30 min. or so required for recovery following bleaching of the visual purple by full light adaptation, is proof of this. The minimum pressure which produces any blindness is about 80 mm. Hg, which is the same as that found by Duke-Elder (1926) to produce slight occlusion and intermittent flow in

the retinal arteries. He found that pressures above 115 mm. Hg produced complete obliteration of the arteries. This corresponds quite well with the 'knee' in the present curves, above which increase in pressure up to the maximum of 225 mm. Hg produces little further reduction in the disappearance time.

The temporary return of vision with eye-movements is explicable in terms of local photochemical adaptation which has been shown to occur in the retina in the region of a bright image by Kühne in his 'optograms'. Such local bleaching would reduce the sensitivity in that part, while eye-movements expose more sensitive areas the response from which can still pass through the region of relative nerve-block.

It appears, therefore, that pressure on the eye provides a convenient method of temporarily blocking the neural connexion between eye and brain and of stopping the retinal circulation without causing disturbances in the concentration of photochemical substances in the retina at the time when pressure was applied. Release of pressure permits recovery in a period very short compared with that of dark adaptation, of the positive after-images resulting from intense stimulation, and of other effects which one may wish to study. Thus pressure furnishes a convenient 'tap' between eye and brain which can be turned on or off at will.

The normality of the dark adaptation curve obtained with an eye which has been blind during the bright adaptation period shows that bright adaptation both of rods and of cones is a retinal reduction of sensitivity and not a cortical one, since the primary stimulation never reached the higher centres.

The absence of delay in dark adaptation caused by a period of pressure shows that circulation—e.g. oxygenation—is not necessary for the regeneration of visual purple and cone substances in the human eye and suggests, even, that the blood may play no part in this regeneration.

V. Summary

Apparatus for detailed investigation of dark adaptation is described. Temporary blindness produced by mechanical pressure on the eye (occluding the arteries and presumably causing retinal anoxia and nerve-block) affords a convenient method for separating processes occurring in the eye and brain. If a dark adapted eye is bright adapted while thus blinded the subsequent dark adaptation curve is the same as if the eye had been bright adapted while vision was normal. This confirms that bright adaptation both of cones and of rods is a retinal process. Dark adaptation is not delayed by pressure applied immediately after normal

bright adaptation, indicating that circulation is not essential for photochemical regeneration. The effect of maintained pressure is to cause a steady rise in threshold which increases for 30–40 sec. The least pressure producing any loss of vision is about 80 mm. Hg, while pressures from 300 to 440 mm. Hg produce complete blindness in a fixed period, indicating complete stoppage of circulation.

PART II. THE PART PLAYED BY THE POSITIVE AFTER-IMAGE

I. *Introduction* (pp. 71–72)
II. *Apparatus* (pp. 72–73)
III. *Procedure* (p. 73)
IV. *Results* (p. 73)
V. *Discussion* (pp. 74–75)
VI. *Summary* (p. 75)

I. Introduction

When the eye has been exposed to a bright light the absolute threshold is found to be raised above its dark adapted value for a considerable period afterwards. The later or rod portion of the dark adaptation curve certainly results from regeneration of visual purple and the consequent increase in the sensitivity of the eye. The earlier portion, however, coincides initially with the period during which a bright positive after-image is seen, so that the rise in threshold might be partly due to the masking effect of this after-image, just as an illuminated background raises the value of the threshold above its absolute value to the value of the differential threshold at that background illumination. The absolute threshold, in other words, may be in some respects a differential threshold for visibility of the test field against the background provided by the positive after-image. It is important for theories of dark adaptation that this masking effect should be separated from 'true' adaptation or reduction in sensitivity of the receptors, since the theory of masking must be in terms of differential thresholds against the background or after-discharge provided by the after-image, while the true rise in sensitivity must be regarded as indicating a reduction in photochemical or neural sensitivity of the receptors concerned. Some method of separating these two effects is therefore desirable.

It is conceivable that light adaptation by lights of different intensities and durations alters the ratio of masking effect to threshold rise; but the

effect is not sufficiently marked to differentiate the two phenomena clearly.

A more promising method is to measure the equivalent brightness of the positive after-image by projecting it on to a dark area with a surround whose illumination can be varied so that a match is obtained at each instant. If we then assume that the masking effect of the positive image is the same as that of a physical field having the same brightness we can estimate the rise in absolute threshold due to this cause from data on the threshold measured against a physically bright background (e.g. the brightness-discrimination data of Steinhardt (1936) for test areas of similar size) and can compare it with the actual value of the absolute threshold at each moment.

Helmholtz (1924, p. 236) pointed out that a positive after-image will be invisible if projected on a uniformly bright background whose physical illumination is such that

$$H = aH + I$$

where H is the subjective brightness of this uniform field around the area of the positive after-image, I the brightness of the positive after-image, and aH the reduced subjective brightness of the field in the area of the positive after-image. This reduction in subjective brightness is of course due to the reduction in visual sensitivity which follows previous light adaptation, and which we are endeavouring to separate from the masking effect. If we also obtain the background brightness, at each moment, for the brightness of the positive after-image projected on a dark area, we have

$$H_2 = I$$

and might obtain the reduction factor a by subtraction of the two equations. This, however, only gives the reduction in visual sensitivity at the brightness H or H_2, where it is already greatly below its maximum; and other errors render the method too inaccurate. The present results, therefore, were obtained by the first method.

II. Apparatus

Monocular vision was used. The bright adaptation of a large area of the whole retina, or of a $3\frac{1}{2}°$ field, was obtained by a system giving a Maxwellian field of 3000 e.f.c. and an artificial pupil 2 mm. in diameter. After 3 min. bright adaptation the subject, wearing an artificial pupil of the same size inserted in a spectacle frame, looked at an opal glass surface having a $3\frac{1}{2}°$ black disc at its centre and illuminated from behind by a 1 W. bulb. The maximum brightness of this surface, which subtended 15°, was 70 e.f.c.; it could be reduced by a variable resistance to 0·001 e.f.c. On the shaft of

the resistance was mounted a pinion which moved a rack with a pencil recording on a polygraph (Craik, 1939). A marker magnet operating another pencil recorded time at 5 sec. intervals. The variation of brightness with resistance was measured with a Holophane lumeter; the scale was found to be nearly logarithmic. The colour change of the light was not a serious disadvantage since the after-image itself changes from impure green to impure brown at intervals and the brightness match can only be approximate under the best conditions.

III. Procedure

The subject fixated the $3\frac{1}{2}°$ bright adapting field for 3 min., then rapidly projected it on to the black disc and modified the brightness of the surround so as to match the image as nearly as possible until the image had completely vanished. This was found to be possible within an accuracy of $\pm 50\,\%$, or better after some practice—i.e. variations larger than these were recognized and corrected by the subject. The course of the positive after-image could usually be followed for about 3 min. The absolute threshold with a test field of similar size was then measured, after 3 min. bright adaptation to the bright adapting field with a field stop removed, so that it had a diameter of 66°. Three subjects were employed.

IV. Results

A typical curve showing the time course of the positive after-image is shown in Fig. 6. The reduction in absolute sensitivity and the portions attributable to true reduction of sensitivity and to the masking effect of the positive after-image are given in the Table 2. They were calculated by the method described above, but can only be regarded as approximate.

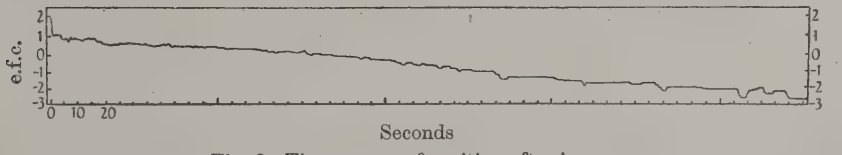

Fig. 6. Time course of positive after-image.

Table 2

(Mean results for three subjects)

Time	Calculated true reduction		Masking effect		Total reduction i.e. 1/threshold rise above value after 5 min.
10″	0·0085	×	0·36	=	0·003
30″	0·22	×	0·12	=	0·026
1′	0·21	×	0·3	=	0·064
1′ 30″	0·35	×	0·6	=	0·21
2′	—		—		0·4

V. Discussion

It appears that the rise in threshold found within the first 10 sec. after bright adaptation is mainly due to true reduction of sensitivity. By the end of 30 sec. the positive after-image has increased in brightness, and for the next minute it and true reduction of sensitivity appear to play approximately equal parts. At the end of 2 min. the positive after-image has decreased considerably and further measurement is difficult. It appears that the remaining elevation of the cone threshold above its final value is mainly due to a true reduction in retinal sensitivity.

While these results are necessarily inexact they indicate that masking by the positive after-image plays a considerable part in determining the form of the dark adaptation curve. They give ground for caution in proposing precise photochemical theories, such as those of Hecht, which claim to decide the order of the reaction involved in cone dark adaptation, in disregard of the alteration of the curve by the positive after-image effect.

It is impossible to estimate the part played by the positive after-image in the rapid recovery of rod dark adaptation after exposure to low illuminations such as 1 e.f.c., owing to the feebleness of the image under these conditions. It would appear, however, that it is a small factor and that the whole of the threshold rise certainly cannot be attributed to it.

The time course of the positive after-image itself as shown in Fig. 1 raises some interesting problems. At first sight, the positive after-image might seem to be a simple retinal after-discharge. This view is untenable, however. The subjective brightness, and presumably therefore the maximal photochemical and neural response (cf. Hartline & Graham, 1932), is highest during the first 5 sec. of exposure of a dark adapted eye to an intense light. Yet the positive after-image has a much longer duration after the eye has become adapted to the high illumination (e.g. in about 1 min.) and its subjective brightness has fallen to a much lower value. Closer examination shows that there is an intense, momentary after-image following high illumination and that it is much less intense when bright adaptation is complete. This may be called the true after-discharge; it lasts less than 1 sec. After short light exposures (e.g. 5 sec. at 3000 e.f.c.) this after-discharge is followed by a short period of complete darkness, after which the main positive after-image appears, and vanishes in another 20 sec. or so. After exposures lasting 1 min. or more this after-discharge is less marked, there is no dark interval, and the main positive after-image is intense and prolonged, enduring for nearly

5 min. This after-image is visible even though the eye has been bright adapted while rendered blind by pressure, as described in Part I, so that it must have a retinal and not a cerebral origin. The most reasonable explanation seems to be that it is connected in some way with the regeneration of the photoproduct, whose concentration is clearly maximal after prolonged exposure to a high illumination. There is no electrophysiological evidence of retinal or nerve after-potentials of such long duration, though the primary response to physical illumination having an intensity equal to the equivalent brightness of the positive after-image in man would be measurable. Since, however, conger eels (Adrian & Matthews, 1927), frogs and snakes (Hartline, 1938) are the only vertebrates in which optic nerve potentials have so far been recorded, it is possible that the evidence is not comparable with subjective results obtained on man.

VI. Summary

The part played by the positive after-image in masking dim test fields and so contributing to the rise of threshold after bright adaptation has been investigated by a matching method which enabled the equivalent brightness of the positive after-image to be measured and its masking effect roughly assessed. It is found to contribute about half the cone threshold rise during the first 2 min. following bright adaptation at 3000 e.f.c. This positive after-image does not seem to be a simple after-discharge but is perhaps connected with the regeneration of a photoproduct in the cones.

PART III. EVIDENCE FROM VARIATIONS IN THE INTENSITY OF THE BRIGHT ADAPTATION AND OF THE SIZE OF THE TEST FIELDS

I. *Introduction* (pp. 75–76)
II. *Apparatus* (p. 76)
III. *Results* (pp. 76–78)
IV. *Discussion* (pp. 78–80)
(1) *Effect of variation in bright adapting intensity* (pp. 78–79)
(2) *Dark adaptation with* 10 *in. field* (pp. 79–80)
V. *Summary* (pp. 80–81)
References (p. 81)

I. Introduction

The mechanism of dark adaptation should be elucidated by varying the conditions under which it is measured. For instance, if dark adaptation consists in regeneration of a photosensitive substance at a rate deter-

mined by the concentration of photoproduct at any instant, the curve showing recovery after various degrees of light adaptation should be constant in shape; the point of commencement will merely be shifted up or down the curve. Hecht, Haig & Chase (1937) carried out an investigation over a limited range of bright adapting intensities.

Any variation in threshold with size of test field should also indicate how far the photochemical mechanism is the essential one, and how far summation between different receptors in the retina is involved.

II. Apparatus

The apparatus used for investigating the effect of variation in the bright adapting illumination was the same as that described in Part I, except that the brightness of 100,000 e.f.c. was obtained by substituting a 250 W. projector bulb for the customary 100 W. For the investigation of variations in test field size a higher field brightness is required than could be obtained with the lantern of this apparatus. An instrument was therefore employed in which the test and bright adapt fields are both obtained by Maxwellian view from one light source. The maximum brightness of the test field was 0·01 e.f.c. It subtended 10 min. of arc at the subject's eye. A 2 mm. artificial pupil was used throughout. Three subjects were used in each investigation.

III. Results

A family of dark adaptation curves from one subject at different bright adapting illuminations is shown in Fig. 7 and curves at 12,000 and 100,000 e.f.c. from another subject in Fig. 8.

Fig. 9 shows dark adaptation curves taken after 3 min. bright adaptation to 12,000 e.f.c. (preceded by dark adaptation) and after

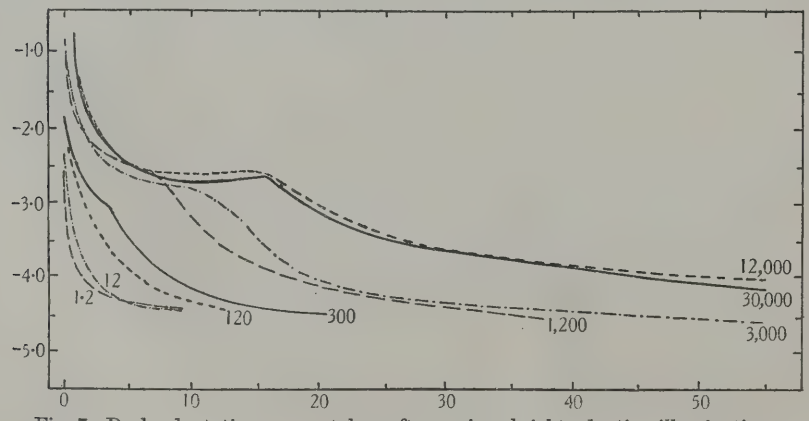

Fig. 7. Dark adaptation curves taken after various bright-adapting illuminations.

10 min. in full summer sunlight, followed by 5 min. gazing steadily at the clear sky. Thus it appears that the 12,000 e.f.c. field given by this apparatus, exposed for 3 min., is sufficient to outweigh any light adapta-

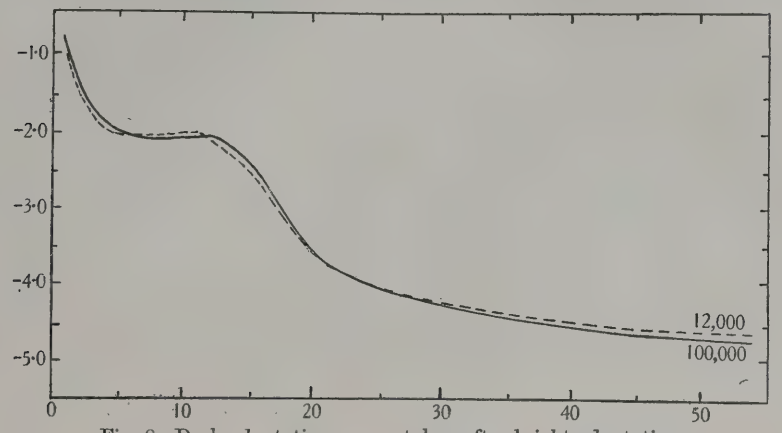

Fig. 8. Dark adaptation curves taken after bright-adaptation to 12,000 and 100,000 e.f.c.

tion which the subject is likely to have experienced in the ordinary course of events. The ability to delete the effects of previous light adaptation in this way is important in clinical investigations of individual variations in dark adaptation.

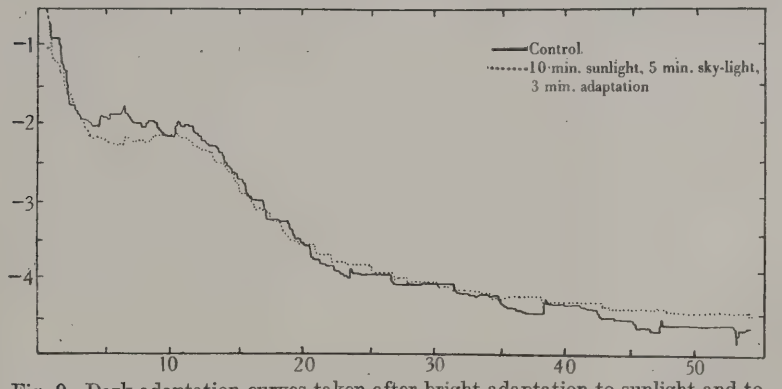

Fig. 9. Dark adaptation curves taken after bright adaptation to sunlight and to 12,000 e.f.c. (Unsmoothed, to show curves as recorded on drum.)

Dark adaptation curves on one subject, taken with 17° and 10′ fields, are shown in Fig. 10 and Table 3. Similar results were obtained on the other subjects.

Table 3. *Threshold in log e.f.c.*

Time in dark min.	Subject A			Subject B			Mean		
	Large	Small	Diff.	Large	Small	Diff.	Large	Small	Diff.
1	−1·7	0	−1·7	−1·5	−0·1	−1·4	−1·6	0	−1·6
5	−2·5	−0·5	−2·0	−2·5	−0·3	−2·2	−2·5	−0·4	−2·1
25	−4·6	−1·5	−3·1	−4·0	−1·0	−3·0	−4·3	−1·3	−3·0

Difference between threshold at 1 min. and at 5 min. with small field = −0·4, and between 1 min. and 15 min. with small field = −1·3. Ditto with large field, another −0·4 and −1·4.

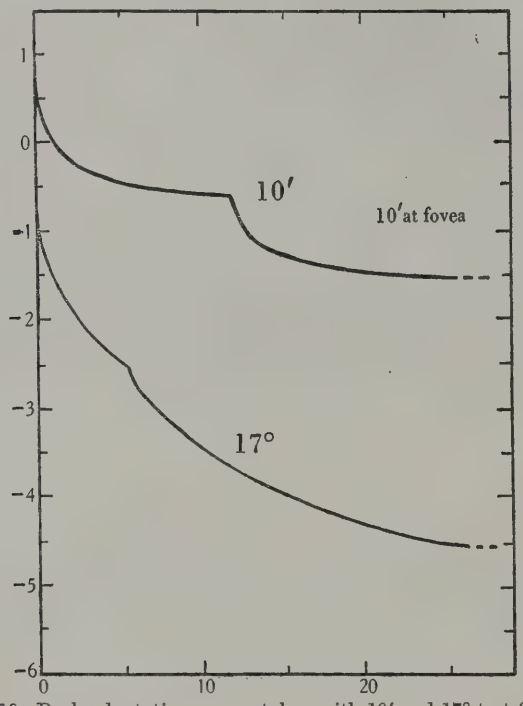

Fig. 10. Dark adaptation curves taken with 10′ and 17° test fields.

IV. Discussion

(1) *Effect of Variation in Bright Adapting Intensity*

Hecht, Haig & Chase (1937) obtained a family of curves showing progressively slower recovery with higher illuminations. They noted a tendency for the delay in recovery to become somewhat less at the highest intensities but concluded in general that "apparently above a light adaptation intensity of 20,000 photons" (about 2000 e.f.c.) "the subsequent dark adaptation curve has a fixed shape but a variable

position on the time axis." Our present results show that, for bright adapting intensities above 12,000 e.f.c., the position on the time axis is fixed, if one disregards the form of the curve during the first half minute of dark adaptation.

The constancy of the time required for dark-adaptation with adapting illuminations above 12,000 e.f.c. seems at first paradoxical, since there is evidence that perfect bright adaptation to these higher illuminations occurs—i.e. that an eye exposed to 75,000 e.f.c. is 10/75 times as sensitive as it is when adapted to 10,000 e.f.c., so that the adapted subjective brightness is identical in the two cases (Craik, 1940). Yet the result fits easily into a photochemical theory of adaptation. The rate of dark adaptation is supposed (Hecht, 1926–7) to be determined by the concentration of photoproduct present at each moment. Now, if the eye has been adapted to an illumination so high that almost all the visual purple has been turned into photoproduct then adaptation to a higher illumination, though reducing the visual purple concentration at equilibrium still further (probably in direct proportion to the adapting light intensity), will add negligibly to the concentration of photoproduct and hence make no measurable alteration in the rate of regeneration or of dark adaptation. Thus, to take an imaginary case, if we suppose that in an eye adapted to 10,000 e.f.c., 99 % of the visual purple is in the form of photoproduct and 1 % remains as visual purple, then adaptation to 100,000 e.f.c. will reduce the visual purple concentration to perhaps 0·1 %. This increases the photoproduct concentration only to 99·9 %, which is practically the same as before.

At bright adapting intensities below 10,000 e.f.c. the recovery, both of rods and cones, is more rapid. The most reasonable suggestion is that of Hecht, Haig & Chase, namely that some intermediate photoproduct is formed by these less intense illuminations and that more rapid regeneration takes place from it than from the final product (possibly vitamin A in the case of visual purple). Although positive after-images are often quite marked after these lower illuminations, it would appear, as suggested in Part II, that they cannot account, by their masking effect, for the whole of this threshold rise from which the eye recovers so rapidly; some true reduction in sensitivity, neural or photochemical, must be postulated in addition.

(2) *Dark Adaptation with* 10′ *Field*

The difficulty of finding any photochemical substance in retinal cones is usually attributed to the much greater dilution of the cone substance

which is thought likely in view of the 500-fold inferiority of the cones as compared with the rods in absolute sensitivity. This result, however, is obtained with large test fields subtending 5° to 15°, and may be due in large part to the greater summation occurring between rods than among cones. Stimulation with a small point of light should almost eliminate such summation and show more nearly the true ratio of rod to cone sensitivity. Hecht, Haig & Wald (1935) measured dark adaptation with fields as small as 2° in diameter, but even here much summation may be occurring, and the 10′ field used in the present investigation was considered preferable.

The results show that after 5 min. in the dark, photochemical sensitivity of the retina, as measured with the small field, appears to have increased only about 5-fold, and 20-fold in 25 min., as compared with its value after 1 min. in the dark. On the other hand, summation increases its sensitivity 20-fold in 5 min. and 200-fold in 25 min. Since the amount of summation increases with time we must suppose that dark adaptation consists partly in an increase in the amount of interaction in the retina with time in the dark, as suggested by Lythgoe (1940), if we assume that the visual purple and photoproducts are rigidly confined within the rods. Hartline (1940) has given electrophysiological evidence (in the frog) of the excitation of a single optic nerve fibre by illumination of several points on the retina and, conversely, of the excitation of several nerve fibres by illumination of a single small area of the retina.

V. Summary

The progressive delay of dark adaptation with increasing bright adapting illuminations has been found to cease at approximately 12,000 e.f.c. This result agrees with photochemical theories which postulate that the rate of dark adaptation is determined by photoproduct concentration since the latter will be almost constant at high adapting illuminations.

Dark adaptation curves have also been taken with a test field subtending 10′. This almost eliminated summation among rods, since few were stimulated. Under these conditions rod vision is only about eight times more sensitive than cone vision, instead of about 100 times as with larger fields. The ratio of the thresholds with large and small fields also increases with time, suggesting an increase of summation during dark adaptation.

Our acknowledgements are due to Professor Bartlett for permission to work in the Cambridge Psychological Laboratory, and to the Medical Research Council for personal and apparatus grants for research on dark adaptation. We are indebted to Flying Officer Honeyman for assistance in the ophthalmoscopic examination of the eye under pressure.

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SPEECH IN AN IMPERFECTLY LEARNT FOREIGN LANGUAGE

By J. CREWDSON

From the Cambridge Psychological Laboratory

I. *Introduction* (pp. 82–83).
II. *Material* (pp. 83–84).
III. *Experimental method* (p. 84).
IV. *Analysis of material* (pp. 84–86).
V. *Treatment of results* (pp. 86–87).
VI. *Results* (pp. 87–96).
(1) *Variations in general behaviour* (pp. 87–88).
(2) *General speech characteristics* (pp. 88–89).
(3) *Special speech characteristics* (pp. 89–91).
(4) *General difficulties of structure and content, as described in introspection* (pp. 91–93).
(5) *General characteristics of language construction* (pp. 93–95).
(6) *Avoidance of abstract situations and description of concrete details* (pp. 95–96).
(7) *Greater ease in description of picture when remembered than when present* (p. 96).
VII. *Discussion and conclusions* (pp. 96–98).
VIII. *Summary* (pp. 98–99).
References (p. 99).

I. Introduction

When a person, imperfectly acquainted with a foreign language, endeavours to speak in that language, certain deficiencies in his performance are easily observed. Some of these he could not avoid, for they result simply from his incomplete knowledge and experience. But it is characteristic that the general level of performance depends to a considerable extent upon the circumstances and conditions in which expression is attempted. So much is a matter of common experience. It is easier to hold a conversation with one person than to join in one with several. Embarrassment or a sense of urgency may limit utterance to an extent not justified by the poor status of the speaker's French or German. Conversation is easiest when it flows in comfortable social circumstances, and its object is the exchange of attitudes rather than of information. It

is most difficult when the occasion demands the expression of precise information or the unravelling of complex circumstance. Fatigue will sometimes render almost speechless one who a few hours before was conversing fluently, and before it has taken full toll of performance, will induce progressive diminution in elegant and sophisticated modes of expression, together with increased tendencies to circumlocution and an incapacity for abstract transactions.

The existence of this fluctuation of performance, dependent on the one hand on the demands made upon the speaker's skill by the type of material he endeavours to express, and on the other by the circumstances in which he tries to express it, offers the possibility of approaches both to the problems of acquiring foreign tongues, and to the problems of language and its disorders in general.

Franz (1) pointed out certain analogies between the performance of the aphasic and that of a person trying to speak a foreign language, and no one who has had experience of aphasia, and has tried to converse in a language not his own, can doubt that the connexion is not fortuitous. In both cases there is an attempt at expression in the face of constraint, in the one case due to disease, in the other to imperfect acquaintance with the language in question. In both cases circumstances and the type of material to be expressed exercise a profound effect upon performance. I shall suggest that there are closer resemblances than these.

The investigation to be described is simple in method, and its scope is not wide, but the results suggest that further experiments along the same lines might be profitable. Two French children, aged eleven and fourteen years (both girls), who were able to speak some English, read prose passages in English, recalled these in English, and attempted to describe pictures shown to them. The linguistic errors were recorded, and are described.

II. Material

Two series of English prose passages were used, each about 140 words in length, and each series consisting of five passages of varying difficulty. In choosing the passages the factors taken into consideration were:

(*a*) Relative familiarity or unfamiliarity of words.

(*b*) Length of sentence (number of clauses contained in each).

(*c*) Relative simplicity or complexity of style (e.g. A 1 is simple, A 3 relatively complex).

(*d*) Subject-matter—abstract, descriptive or narrative.

(*e*) Relative proportion in which different parts of speech occur in the passage. (The fewer the nouns, and the greater the number of adverbial

expressions, prepositions and pronouns, the more difficult the passage tends to become.)

The third series used consisted of four drawings of varying complexity, complexity having reference to the idea or situation expressed by the picture.

III. Experimental method

Passages of Series A were presented singly to the subject, who was instructed to read the passage aloud to the experimenter. Having done this, the subject was allowed to re-read the passage silently, twice through if necessary, and then asked to state its contents in English to the experimenter, who took down as nearly as possible an exact account of what was said.

Series B was presented to the subject in exactly the same manner, but the subject, having read the passage aloud, was asked to re-read it aloud with a view to recalling it to the experimenter subsequently in French.

Series C, consisting of drawings, was presented singly to the subject, who had to describe what she saw. When she had done this, the drawing was removed, and she was asked to describe verbally in English what she remembered of the picture.

The subjects were on holiday at the time of the experiments. In order to secure full co-operation and attention, it was found advisable not to give them more than one passage and one drawing a day. The experimenter was well known to the children, and after the first day both appeared to be thoroughly at ease in the experimental situation.

IV. Analysis of material

Series A. A 1. A descriptive prose passage entitled "At the Seaside". It contains familiar words, simple constructions and a familiar theme. (The children were at the seaside at the time of the experiment.) The style is extremely simple—it might be described as 'childish'. The verbal content is mainly nouns, verbs in simple tenses, and adjectives. It contains very few adverbial expressions, and only the very simplest concepts of spatial and temporal relations, e.g. "a castle with a wall all round it" and "until the sea came and washed it away".

A 2. "A Fairy Story" is a narrative prose passage with a connected theme running through it. The words are mainly familiar, except for one or two such as "wedding", "flattered" and "therefore". Some of the sentences in A 2 are longer than in A 1, containing up to three clauses. Spatial and temporal relations are still extremely simple.

A 3. "The Black Road" has a less concrete theme. It is mainly descriptive, but an intellectual idea runs through it, which depends for recognition on a grasp of the passage as a whole. It contains some words of a less familiar type, such as "errand of

mercy", "starred", "christenings". The sentences are of varied lengths, the longest containing four clauses. The style is flowing and more artistic than that of A 1 and A 2.

A 4. "Death among the Poor" contains description of action. The difficulty of this passage lies mainly in the length of the sentences. The whole passage only contains five sentences, the longest of which has six clauses. The words are relatively familiar, except for "undertaken". The style is straightforward and unadorned. Understanding of this passage, however, involves appreciation of certain more subtle relational concepts, both temporal and directional, such as "it was no longer light", "hardly visible" and "through the passage".

A 5. "Hypnotism" has an abstract theme of a rather documentary type. The words are mainly familiar, except for "perform", "anaesthetics" and "soothed". The sentences are also comparatively simple, there being only one of more than two clauses. The style is heavy, and there is no definite connecting thread running through the passage. A certain grasp of temporal relations is involved in the phrase "Since then...". The difficulty of the passage lies rather in the ideas than in the words or style.

Series B. B 1. "A Large Farmhouse" is a simple descriptive passage, but containing slightly longer sentences and more nouns than A 1.

B 2. "Robin Hood" is a narrative passage, containing a relatively large number of nouns. Certain words, such as "bow", "quiver", "*provide* for himself", "*slung* on his back" and "summon" are unfamiliar, but the rest are fairly common. The sentences are longer than in B 1, but do not exceed three clauses. The style is straightforward, but not as simple as that of B 1. The only temporal relationship involved is in the sentence referring to Robin Hood's uncle.

B 3. In this passage, "A Dream", there is about the same proportion of familiar to unfamiliar words as in B 2. "Clutched", "growled", "bed-post", "toss", and "sheet" are fairly unfamiliar. Like B 2, it is a narrative passage, but with a rather unusual theme. The sentences contain mostly from two to three clauses, but the construction is complicated by the fact that action and simple description are intermingled, with a resulting mixture of tenses. Certain sentences involve complicated temporal relations, e.g. "M was just wondering what could have happened when...." The style of the passage itself is simple.

B 4. "Heroism of a Miner" is a detailed narrative passage. It contains a large number of words, of which a few are unfamiliar: e.g. "shaft", "kindle", "accordingly" and "blasting". The construction is complicated, with many sentences of three clauses, and several of four, and many additional phrases such as "leaving him to his fate...", "taking two stones...", "horrible to relate...". One sentence was complicated by having an adverbial phrase in the place of subject, namely, "One at a time was all the assistant at the top could manage". The difficulty of the passage lies mainly in the length of the sentences. Also, recognition of both spatial and temporal relations is involved in understanding the passage, i.e. that the men had to be pulled up one at a time, and that one was to be drawn up to the top, while the other was still at the bottom of the pit.

B 5. "The Effect of a London Fog" is a descriptive passage of an abstract nature. The words are familiar. The sentences are from two to four clauses long, but the constructions are difficult, and a grasp of temporal relationships is essential. Certain events occur during a fog, some after it, and one reference is made to events which had

happened some time previously. There is no definite connecting thread running through the passage, but a general idea underlies it, namely, that a minor misfortune has the paradoxical effect of making people cheerful, and this idea must be grasped in order to understand the passage as a whole.

Series C. C 1 is a woodcut of a man leaning over a gate looking at a view of fields, haystacks, a farm cart, and farm buildings. That is the whole situation. In giving an account, nothing but a simple description is needed.

C 2 is a simple line-drawing from *Punch* of a portly butler bending down to turn the key in the keyhole of a door, holding a candle in his other hand. The picture suggests several possible situations. The most likely are (*a*) that the butler is going down to the wine cellar after the household has gone to bed, and (*b*) that he is locking up the front door before retiring himself.

C 3 is a humorous strip-cartoon from *Punch* entailing description of certain actions, situations, and also of the feelings and motives of the persons concerned.

C 4 is a political cartoon of a more subtle kind. It represents the Drake-Armada situation of modern politics. Chamberlain, dressed in Elizabethan clothes, is playing bowls while bombers bomb our warships out to sea. Unfortunately, neither the humour, nor the significance of the picture, were recognized by the subjects, and its value as representing a rather involved situation was therefore lost.

V. Treatment of results

The experimental results took three forms:

(*a*) Records of what was actually said in response to the task.

(*b*) Notes of general behaviour and speech characteristics.

(*c*) Introspections.

(*a*) Records of the subjects' remembered account of a passage or picture were not always as accurate and comprehensive as was desirable. The subject often spoke too fast for her account to be taken down word for word. Errors of pronunciation and construction, however, were noted as carefully as possible.

(*b*) In describing general behaviour, and the characteristics of speech, a scheme was drawn up and a note made indicating to what extent each given characteristic was present or absent from the record. Thus notes on general behaviour referred to (1) *general expression of the face* (whether strained, smiling, etc.), (2) *movement of the mouth and lips* (whether exaggerated for the production of sound, (3) *general posture* (whether strained or fidgety, etc., hands). These characteristics remained fairly constant on the whole.

With regard to the characteristics of speech, the more general characteristics were found by the experimenter to remain fairly constant throughout the whole series of experiments. These were *pitch of voice*, *intonation* and *loudness*. *Speed of utterance* also appeared to remain fairly constant, but unfortunately the experimenter was unable to make

an accurate measure of speed, since she had no stop-watch, and the variation in length of time taken to read a passage could never have been more than a few seconds.

Other, more specific, characteristics varied a great deal, and appeared to be more significant as indications of the ease or difficulty of a given passage. These were:

(*a*) General rhythm of sentence, whether matched to sense and syntax or not.
(*b*) Tendency to slur words.
(*c*) Tendency to contract.
(*d*) Hesitation.
(*e*) Alterations.
(*f*) Repetitions.
(*g*) Stuttering.
(*h*) Mispronunciation.
(*i*) Types of grammatical error.
(*j*) Tendency to simplification.

The experimenter was again handicapped to a certain extent in recording the above characteristics, since she was naturally unable to direct her attention equally to all aspects of the subject's speech and behaviour at once, and minor differences in pronunciation were sometimes unavoidably overlooked.

(*c*) *Introspections.* An attempt was made to obtain full introspective reports from the subjects after each passage. This included an account of any visual imagery the subject might have had, any unfamiliar words or difficult constructions, any tendency to translate, or to remember certain words and phrases rather than others.

VI. RESULTS

(1) *Variations in general behaviour*

The general behaviour of the subjects varied little. The only signs of strain which were elicited under specially difficult conditions were fidgety movements of the *hands*, and a worried *facial expression*. This occurred usually when the subject was trying to remember something. She also sometimes looked round the room with an expression of concentration, but for the most part she looked either at the table or at the experimenter. Her *expression* was usually serious or pleasantly interested in the task. *Lip movements* were consistently slightly exaggerated by English standards, but they did not vary noticeably except in the case of Subject 1, who sometimes exaggerated *h* sounds considerably, protruding her lips, opening her mouth wide, and taking a deep breath. This was due to a

natural difficulty in sounding *h* at all, and occurred whenever the subject's attention was anxiously directed to sounding her *h*'s. B 2 provides a good example in which the subject's attention was "*h*-directed" throughout. Not a single *h* was dropped, and none were over-exaggerated. The same thing occurred in this passage with Subject 2. Subject 2 dropped a large number of *h*'s in the first reading, ending with "...while the captain always 'ad a 'orn with 'im, to summon 'is followers about 'im...". At the second reading, however, she became *h*-directed, and over-emphasized seven *h*'s, dropped none, and inserted two extra ones—namely "*h*into" and "*h*outlaws".

(2) *General speech characteristics*

Both subjects spoke in a very monotonous, *high-pitched voice*, which never varied. There was a complete *lack of intonation*, and each passage was read throughout at an even, high pitch, with no variation of loudness, and no light and shade. The *speed of reading* was also fairly constant, no noticeable variation taking place, but it was impossible to measure this factor accurately. *Hesitation* occurred frequently, and *repetition of words* less frequently. This was sometimes due to a word being unfamiliar, or to the subject not knowing how to pronounce it. At other times it was due to the length of the sentence or the complexity of structure, and at other times, again, no definite reason could be put forward to explain it. *Stuttering* appeared to occur for the same reasons, namely, unfamiliarity of words or constructions.

The *general rhythm of speech* was jerky. In the easier passages, as might be expected, the sentences ran more smoothly than in the harder ones. In the case of Subject 1, A 1 and B 1 were read extremely smoothly the first time, with no gaps in the rhythm. At the second reading of B 1, however, the subject's attention was directed to the sense of the passage, and the rhythm became broken up in different places. In the harder passages, however, there was a tendency for the rhythm to improve slightly at the second reading, which indicated that familiarity with the material was a more important factor than attention, once a certain degree of difficulty had been reached. This tendency is shown in Table 1.

There is a certain amount of correlation between the number of breaks in rhythm and the difficulty of the passage in the case of Subject 1. Subject 2, however, shows no significant tendency in this direction. Although the sense of a sentence was sometimes ignored by breaks in the rhythm, the rhythm always fitted in with the syntax. That is to say, full

stops and other punctuation signs were always marked by small breaks in the rhythm, although there was no change in the intonation.

Table 1. *Number of breaks in rhythm*

	Subject 1		Subject 2	
	1st reading	2nd reading	1st reading	2nd reading
Series A 1	0	—	3	—
2	3	—	0	—
3	7	—	5	—
4	10	—	10	—
5	5	—	6	—
Series B 1	0	5	1	3
2	4	5	12	13
3	10	4	0	0
4	17	9	5	7
5	13	4	12	12

(3) *Special speech characteristics*

A certain number of characteristic faults of pronunciation tended to appear during speech. These are:

(1) *Th*-sounds pronounced *s* or *f*.
(2) *h*-sounds dropped.
(3) Vowel sounds changed or modified.
(4) Mute syllables sounded.
(5) End syllables left unsounded.
(6) Contraction of syllables.
(7) Wrong emphasis.

The most common faults were the first two, which seemed to give a better indication of difficulty in a passage than any other characteristic, since subjects were conscious of their tendency to drop *h*'s and mispronounce *th*'s, and were sometimes able to eliminate these errors by conscious effort. Thus they tended to lapse in these respects whenever a passage presented particular difficulties. A good example of this is shown by Subject 2 in B 5. The first two sentences were read correctly. Both the second and the third, however, were particularly difficult, and this caused her to say—"One at a time was all *se* assistant at *se* top could manage." Two more *th*'s were turned to *s*'s farther on in the passage, where the subject afterwards reported great difficulty, and once more at the end, at another complicated point.

Mispronunciation of vowel sounds also occurred fairly frequently. This was sometimes due to ignorance of the right pronunciation, but discounting these cases, there seemed to be a slight tendency for the number of mispronounced vowel sounds to correlate with the difficulty

of the passage. A table is given (Table 2) showing the number of these mispronunciations occurring during the first reading of Series A and B for both subjects. Vowel sounds were mispronounced far more frequently during reading than during spontaneous speech. In the latter it only occurred where the words were unfamiliar, and the subject was uncertain of the correct pronunciation.

Table 2

Subject	A 1	A 2	A 3	A 4	A 5	B 1	B 2	B 3	B 4	B 5
1	1	3	3	4	4	3	2	4	5	8
Subject 2	1	5	2	5	5	4	4	—	8	9

Mispronunciation took various forms:

(1) Vowel sounds were sometimes completely changed: e.g. *en*tered to *on*tered (A 4, S 1), *ea*sy to *a*sy (A 3, S 1), gr*ea*t to gr*ee*t (A 2, S 1).

(2) More often a short vowel was lengthened: e.g. g*i*ve to g*ī*ve (A 2, S 1), m*ea*dow to m*ee*dow (A 1, S 2).

(3) Or a long vowel was shortened: e.g. b*ea*st to b*e*st (A 3, S 2), c*a*me to c*a*m (A 1, S 2).

(4) A mute syllable might be pronounced: e.g. excitement to excit*er*ment (B 3, S 1), soothed to sooth-*ed* (B 3, S 1).

(5) A final syllable might be omitted: e.g. complet*ed* to complet/ (B 5, S 2).

(6) Very occasionally syllables were contracted: e.g. happ*i*ness to happ'ness (B 3, S 1), accord*ingly* to accord*ling* (B 4, S 1), cur*ious* to curos (B 3, S 1).

Another characteristic of mispronunciation was *wrong emphasis*. This occurred comparatively frequently, but was only slightly more frequent in reading than in spontaneous speech. The experimenter was inclined to believe that errors of emphasis varied less than other characteristics with changes in the difficulty of material. It appeared rather to be a constant characteristic of speech due directly to the influence of the French language. For example, a lingering emphasis occurred frequently in the last syllable of a word, e.g. mast*er*, wee*ping*, hand*some*, short*er*. This is a common characteristic of French pronunciation. Secondly, wrong emphasis occasionally occurred in the middle of words, e.g. vehemently, imagin*a*ble. This was almost certainly due to similar emphasis in the corresponding French words. Finally, as Table 3 below shows, there was no tendency for the number of wrongly emphasized

Table 3. *Number of wrongly emphasized words in a passage*

Subject	A 1	A 2	A 3	A 4	A 5	B 1	B 2	B 3	B 4	B 5
1	2	4	1	5	1	1	3	7	4	0
Subject 2	0	4	1	0	0	1	3	0	6	0

words to correlate with the order of difficulty of the passage. This supports the suggestion that wrong emphasis is a fairly constant characteristic of speech under these conditions, and that its occurrence is not affected significantly by the difficulty of a passage.

(4) *General difficulties of structure and content, as described in introspection*

(1) *Length of sentence.* The factor which caused both the subjects the greatest difficulty was length of sentence, or number of words in a phrase. They frequently complained during introspection that there were "too many words", that they knew them singly but could not understand what they all meant together. B 4, for instance, contained a great many sentences which troubled the subjects in this way:

"One at a time was all the assistant at the top could manage."
"Taking two stones, a flat and a sharp, he succeeded in cutting it to the right length."

The whole of the last sentence, from "Both shouted..." gave an impression of confusion, but this is not only due to the length of the sentence, but also to the fact that the nouns are replaced by "both", "he" and "them". This latter factor will be referred to later.

(2) *Complicated verb structure.* Long verbs were another source of difficulty to both subjects. However familiar the verbs were in simple tense form, they tended to lose all significance when met with in a compound tense, or in conjunction with another verb.

E.g. S 1, B 3. "One night he could not go to sleep."
("Couldn't grasp the meaning of this.")
S 1, B 3. "...was just wondering what could have happened."
S 2, B 2. "His uncle had been persuaded to leave his property...."
("Forgot the meaning after reading it.")

One result of both these complicating effects was that the subjects were unable to remember the beginning of the sentence by the time they had reached the end. In B 5, for example, the last sentence, beginning "One reason is...and the other is..." was rapidly forgotten, although each bit was understood at the time of reading. Similarly in B 3, S 1, "He tossed about and woke his brother John, who growled at him drowsily." ("I couldn't remember the sense of this after I had read it.")

(3) *Temporal and spatial relationships.* Expressions involving temporal relationships presented great difficulty to both subjects. This, no

doubt, was an important reason for the confusion caused by complicated verb structures.

E.g. B 2. "His uncle had been persuaded...."
B 3. "...was wondering what could have happened."
A 5. "He will perform actions long after he has awoken from his hypnotic sleep."

Spatial relations of any degree of complexity also caused confusion.

E.g. A 4. "...so creeping cautiously through the dark passage and bidding Oliver keep close to him...." ("Got involved in that. It is very complicated.")

B 4 also demanded a grasp of spatial relationships, namely those of the positions of the two miners and the assistant. But it is significant that neither subject was able to give a coherent account of the situation.

(4) *Isolated unknown words.* A less frequent source of difficulty was that of meeting single words whose meanings are unknown. Normally this did not affect the subject much, as long as the word was not essential to the general sense, but occasionally one strange word affected understanding of the whole sentence. This happened to S 1 in B 5. She did not know the meaning of "accordingly" in "accordingly tried to break it shorter"; and this affected her so much that she was unable to understand the rest of the sentence.

(5) *Abstract ideas.* Passages containing abstract ideas appeared to be more difficult than descriptive or narrative passages. Both S 1 and S 2 complained that the "ideas were difficult" in A 5 and B 5, and S 1 said that the sentences were disjointed and "décousu"!

(6) *Lack of nouns.* Owing to the ease with which both subjects tended to forget what has gone before, and even the beginning of the sentence they were just reading, they naturally tended to cling to those words which recall the subject-matter of the sentence, and the general sense of the whole passage. Since it was mainly nouns which had this property, passages containing relatively few nouns were more difficult than others. Thus passages containing a large number of pronouns and relative adjectives, which have no meaning in themselves, caused the subject great confusion. E.g. B 5, "Both shouted vehemently to the assistant; both sprang to the basket, but he could not lift them both at once." This sentence contains only two nouns "assistant" and "basket". The sentence was found to be very complicated by both subjects, who

could not even understand the general sense, although all the words were familiar to them.

(5) *General characteristics of language construction*

As might be expected, all those factors which cause the subject any difficulty in reading prose are eliminated as far as possible in spontaneous speech, and where this is impossible, grave difficulty is encountered. The spontaneous speech of the subjects was characterized in general by the following tendencies:

1. Simple sentences, containing rarely more than one subordinate clause.
2. Simple verbal constructions. (*To be* is used as far as possible.)
3. Frequent disturbance of *th* and *h* sounds.
4. Great difficulty in expressing temporal and spatial relations.
5. Repetition of nouns, and avoidance of pronouns.
6. Tendency to translate literally, or to repeat parrot-like.

The above tendencies can best be observed by reading the actual reports made by the subjects in Series C, and in the second half of Series A. As these show, the longest sentences contained not more than three clauses, of which one is almost invariably connected by "and". More than one relative clause never appears at a time. Verbs present peculiar difficulty. The verb *to be* is used whenever possible, and this is usually used correctly, but any other verb tends to be either in the wrong tense or the wrong person. Mistakes of this kind are not simply due to ignorance, since the experimenter was satisfied that verbs could be correctly used in ordinary conversation. The subjects often dropped the final *s*, as in C 3, S 2: "The osser Mister look/ at se first", or as in C 4, "put/", "fall/", "go/", "open/", for the corresponding third person singular forms. Similar errors of number are occasionally made in nouns, such as "pupil/" for "pupils" in C 4.

Errors of *th* and *h* pronunciation occur relatively more frequently in spontaneous speech than in reading. Subject 2 was relatively worse than Subject 1 in this respect, which is interesting, since they had approximately equal scores of 51 and 49 over the whole of Series A and B, but in Series C Subject 1 had 22, and Subject 2, 58. This can probably be explained by the fact that Subject 1 was older than Subject 2, and had had more practice in talking English with the experimenter. She was consequently more familiar with the "speaking situation" although her actual standard of expression was no better than that of Subject 2.

Considerable difficulty was found by both subjects in expressing temporal or spatial relationships. Thus in C 4, Subject 2, unable to say that the pot of water fell on the boy's head, said instead: "A pot of water hit on him" in C 4, Subject 1 said "...and they are before the water..." meaning "by the sea". In the same passage the same subject said "...and turn the back of the sea..." meaning "turns his back to the sea". In A 1 she said "all around the wall" meaning "with a wall all round it"!

Temporal relations were almost entirely ignored and prepositions continually misused. "At" was used for "to", "on" for "in". We find "shoot *in* the boat" for "shoot *at* the boat", "*on* a wall" for "*against* a wall", "*in* a hill" for "*on* a hill".

When the subject was in difficulties she also tended to drop articles, e.g. "I see farmer on his cart with black horse" (C 1). The same difficulty, caused by lack of nouns in prose passages, appeared for Subject 1 in spontaneous speech. She reported a tendency to forget what she was talking about in describing a picture, and this led her to repeat nouns instead of using pronouns, as a reminder of what she had just said. E.g. in C 2, she reported "When I have said one sentence, I pay attention to the next, and forget what I have just said, so I must repeat the word to remind me." E.g. "This man" instead of "He." "If I use the pronoun I get mixed up between people and objects". Similarly in C 3, she constantly repeated "the pupils", "the basket of books", "the master", instead of using the relative pronoun. C 1 illustrates this repetition admirably: "This farmer reaches his farm", "This farm was...", "This farmer looked at...", "this farmer smoked...". She was aware of the repetition, and said "I could not link my ideas up properly, which is why I repeated the noun".

A second aid adopted by Subject 1 to help her to remember what she wanted to say was to decide what she wanted to say in French, and translate it literally into English. She did this also when describing a picture from memory, instead of attempting to remember her previous description in English. Thus in C 2 she said, "He bears a (candle) in the left hand, and he leans to see the aperture". She knew the words, "carry", "bend" and "hole", but she felt compelled to keep the words as close to the French as possible.

In describing Series A from memory, Subject 1's methods were different. She relied almost entirely on her memory of the words and constructions used in the passage. When this broke down, she was more at a loss than was Subject 2, who relied less on memory of words, and more on memory of sense. A good example of the difference in method is

shown by comparing the reports of the two subjects in A 3. The following is an account of Subject 1's report of the passage, leaving out mispronunciations, repetitions and gaps:

The road was built long ago for the man and beast. It was a pleasant windy ribbon. The banks on either side—starry—flowers—unimaginable—and deep in grass. On the road there were christenings, funerals, weddings. The doctor go by on his errand, the farmer on his car, Madam on her carriage. Nowadays—unaccustomed—dare be free—to him.

In her introspection she said, "I relied on my memory of individual sentences. Did not bother about general sense in describing it." Subject 2 said:

The road was then large, and easy for the feet of the travellers and the bare feet of the children. On every side there was flowers—no—all imaginable flowers. It meant weddings, christenings, funerals, the doctor in his carriage, farmer in his cart. Now the road belongs to the motorist, and it is rugged to unaccustomed feet.

Afterwards she said, "I tried to remember the sense rather than the words, but had to learn two words I didn't know". She left out the sentences she did not understand.

It seems unlikely that this difference in method could be due to a difference in knowledge of English. Subject 2 was two years younger than Subject 1, had done a year's less English, and had a slightly smaller vocabulary. On the other hand, judged on a basis of school achievement and general observation of the experimenter, Subject 2 appeared considerably more intelligent than Subject 1, and it seems probable that the method adopted by the former in remembering and describing A 1 depended on her superior intelligence rather than on the degree of knowledge she possessed.

(6) *Avoidance of abstract situations and description of concrete details*

One marked tendency which was evident in the results of the Series C experiment was the avoidance of any attempt to describe situations, ideas, or motives. Both subjects directed their attention wholly to description of concrete details and objects.

Series C 1 to C 4 are arranged roughly in order, starting with complete absence of underlying situations or ideas, and ending with a picture in which the idea is all-important, and the details insignificant.

In C 1, neither subject attempted to describe anything that was not there in the picture. In C 2, Subject 1 described, the first time, only what

she saw in the picture, but in the account from memory, she attempted to supply a motive by saying "to fetch perhaps a bottle of wine". Subject 2 merely described the bare details.

C 3 provides more opportunities for discussion of motives, ideas, etc. Subject 1 made a valiant attempt to express the situation by saying "two pupils have imagined to put in a basket many books and to make a trick to the master". Farther on she noted that the pupils laughed, and the master was angry. But this again is only describing what she actually saw in the pictures. She made no attempt to explain why the head-master called the boys to his study, nor that it was he who placed the jar of water on the door to get his revenge. Subject 2 never rose above the level of concrete description throughout. She made no mention of motives or attitudes on the part of the master or pupils.

Unfortunately C 4 was badly chosen by the experimenter since the children neither saw the reference to Drake and the Armada, nor the significance of the picture in connexion with current politics in England. No attempt was made therefore to describe the idea underlying the picture. This cannot be attributed to the language constraint, but was simply due to lack of comprehension. Neither subject attempted to give the picture any meaning at all, but Subject 2 remarked that "It is funny, for there were no aeroplanes in the mid-age".

(7) *Greater ease of description of picture when remembered than when present*

A final point of interest in connexion with the results of Series C was the greater ease of description when the picture was not present. During introspection Subject 1 said several times "I found it easier to describe without the picture, because I could follow my ideas without having to attend to what I saw before me" (C 4).

This appeared to apply to both subjects, since reports from memory were almost universally more coherent and better constructed than descriptions of the actual picture. This is particularly apparent for Subject 1 in C 2 and C 3, and for Subject 2 in C 1.

VII. Discussion and conclusions

Learning a language, like speaking a language already acquired, involves the double task of knowing the meaning of single words, and of using them in different contexts, which may alter their general sense and give them significance only in relation to the whole setting in which they

stand. Thus the meaning of the sentence is prior to the meaning of the words composing it, and comprehension of a sentence or a paragraph depends upon the ability of the individual to treat the sentence as a unit of meaning and to relate one unit to another. This ability breaks down in the case of language constraint, and the results of our investigation give ample proof of it. Anything which affected the complexity of the sentence as a unit of meaning—number of words, complexity of construction, unknown words, words lacking intrinsic meaning-value (e.g. "he", "which"), degree of abstraction of the ideas expressed—all tended to create difficulties for the subject in her efforts to treat the sentence as a whole and to relate it to other wholes. The same difficulties appeared in spontaneous speech, where the subject was forced to adopt certain devices for remembering the whole sentence, such as repeating the noun, and translating from French, keeping as closely to the constructions and words of the latter as possible.

These results show a certain similarity to those of Oldfield & Zangwill in their experiment on memory (3). They concluded from their results that the first stage of learning is probably the formation of a general scheme incorporating some dominant detail. They suggest that intrinsic meaning is very important in scheme formation, and must be taken into account in any theory of remembering. It seems likely that the same principles apply in language learning. Introspective evidence shows that in order to reproduce a passage, the subject's main consideration was to get a general scheme or to grasp the general sense of the passage. When lack of knowledge or the abstract nature of the material interfered, the subjects frequently resorted to a "parrot" method of learning. Subject 1 often adopted this method, but Subject 2 attempted to form a general scheme wherever possible. This is of some interest since it shows that the material to be learnt does not entirely decide which method of remembering shall be adopted. Other things being equal, two subjects may yet adopt different methods of learning the same material. The experimenter is inclined to think, on the evidence obtained from Subjects 1 and 2, that this individual difference is probably due to some factor such as general intelligence.

Finally, the results indicate that the most important reaction tendency in verbal reproduction of material in a foreign language is reversion to a more primitive mode of reaction. Literal translation and dropping *h*'s are two of the most obvious types of reversion, and no doubt other characteristics of language construction and pronunciation are probably indirectly of the same nature.

The general similarity between the speech of an aphasic and the speech of one who is in the process of learning a foreign language has already been pointed out in the introduction, but there are certain specific tendencies which seem to indicate the fundamental similarity of the two types of "disorder".

The first and most striking of these is inability to express ideas of spatial and temporal relationship and to deal with ideas of any considerable complexity. This tendency to simplify ideas is a symptom of semantic aphasia. People suffering from this disorder are unable to comprehend the general significance of a set of details or the principles underlying a game etc. They talk rapidly as though they were in danger of forgetting what they wanted to say. In reading they tend to forget the beginning of a sentence before they reach the end, and therefore they cannot grasp the general significance of a story or a joke. In speech in a foreign language, the same defects are apparent, especially in relation to the comprehension of abstract ideas, or sentences involving a large number of words.

The other types of linguistic defect, the verbal syntactical and nominal, are also present to a certain degree in speech in an imperfectly learned foreign language. But they cannot easily be distinguished, since their occurrences are causally inter-related to one another and to the semantic type.

A second point in common between aphasic speech and speech in a foreign language is the effect which complexity of ideas or of logical structure may have on articulation and grammatical structure. The aphasic can often pronounce and articulate correctly only in simple circumstances. Where the problem he is posed is more complicated his articulatory processes tend to break down. An exactly similar effect is found in speech in a foreign language.

VIII. Summary

An investigation was carried out with two French children of 11 and 14 years to study the ways in which speech is disturbed in a foreign language. The methods used were those of *Reading*, *Description* and *Recall*, the investigation being conducted in English. Certain types of breakdown were found in speech under these conditions which resemble defects found in aphasia. The chief of these were: (*a*) tendencies to simplification; (*b*) tendencies for difficulties in the material to be expressed to reflect upon the articulatory processes; (*c*) tendencies to revert to a more

primitive mode of speech reaction; (*d*) tendencies to avoid abstract features of the material.

It is thought that the investigation suggests further lines of work which might be of importance to the study of aphasia, of the learning of foreign languages and of language generally.

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PUBLICATIONS RECENTLY RECEIVED

Colour Co-ordination. By M. SARGENT-FLORENCE. London: The Bodley Head. 1940. Pp. 352.

The author is an artist who sets out to find "some working basis of agreement" between scientists and practical colorists in regard to colour theory. The book consists largely of a diffuse discussion of the musical analogy for the relation of the spectral colours, as developed by Newton, Ostwald, and others. Unfortunately, the writer does not make the contribution to the subject which an artist can and a scientist very often cannot—a significant and sympathetic statement of the colour relationships actually used by artists to express certain feelings or situations. A reliable discussion of such colour relationships and their meaning—an indication of those appositions of colour which are essential in a picture and those which are more or less coincidental and of those which satisfy and those which offend the trained artist—would be valuable to the psychologist or physicist. This book almost completely lacks such discussion. Almost the only actual colour situation discussed is that of a butcher's shop with red meat, buff paint, and the blue apron of the butcher—hardly a typical instance of art! The fundamental difficulty lies deeper, however. The author fails to show an understanding of the basic principles and purposes of scientific method, and for this reason is not likely to obtain the sympathy of the physicist. For instance, great pains are taken to defend the musical analogy for the spectrum against various specific objections of numerical dissimilarity; but there is a failure to see that the justification of hypotheses in science comes mainly from their scope—not from the ability of their proposers to defend them against each criticism in turn. The concept of the octave in music is accepted not just because it is an ingenious nomenclature, but because all European music is built on this scheme and the correct or incorrect sound of harmonies can be traced to the (conscious or unconscious) obedience or disobedience to its rules. Harmony is thus a set of laws applying, in a quite rigid manner, to a wide realm of facts; and in this it resembles a set of physical laws. But the mere numerical pattern, borrowed from music and applied to colour, accomplishes nothing. It is the propounding of laws which work, and nomenclature that suggests new facts, which constitutes science—not just the invention of a complicated terminology for its own sake. Yet it is this purpose of scientific nomenclature and hypothesis which the author seems throughout to ignore; one gets an impression that the task of colour science is accomplished if the musical analogy for colour can be made just 'water-tight'; the possibility that it should have a further purpose, and be justified by its accomplishments, seems never to occur. K. J. W. C.

The Structure of Art. By CARL THURSTON. University of Chicago Press (Cambridge University Press). 1940. Pp. xiii + 190. 72 illustrations. 15*s.* net.

The great merit of this book is that it arouses a lively interest in the phenomenal nature of the complex aesthetic experience, and its relation on the one hand to the 'form' of the work of art, and on the other to its 'meaning' as based on the memories and personality tendencies of artist and observer. The author wisely limits his study to the 'spatial' arts; and in dealing with simple shapes, decorative art, architecture and sculpture, he successfully indicates some at least of the essential features in the relation of 'form' and 'meaning'. But he would be somewhat easier to follow—and his study would be more 'scientific'—if he included more specific detail and some actual experimental data relating to the phenomenal processes involved. The complexity of

painting is such that he is able to deal with it only in generalities, without any detailed analysis; although his emphasis on the necessity of taking into consideration the temporal aspects of the aesthetic experience is interesting and suggestive. The psychologist would welcome a more detailed and systematic psychological analysis of the relation to 'experience' and 'meaning' and the dependence of these upon personality.

The German Mentality. By 'VERRINA'. London: George Allen and Unwin, Ltd. 1940. Pp. 257. 10*s.* 6*d.* net.

This book presents a recital of "the evil things" which have been the outcome of the "German mentality". It fails to provide any analysis of that mentality itself. The factual material is not fresh to the English newspaper reader, and is wholly undocumented. The author's tone hovers between heavy sarcasm and disgruntled moral condemnation. The book will be of very limited value to psychologists.

The Child's Discovery of Death. By SYLVIA ANTHONY. London: Kegan Paul, Trubner, Trench and Co., Ltd. 1940. Pp. xvi+231. 11*s.* 6*d.* net.

The author of this book has collected together a large amount of interesting data on children's ideas and phantasies of death, using records of children's ordinary conversations, stories completed from set themes, and answers to certain of the questions in the Terman Merrill revision of the Binet Simon test. Perhaps the most interesting psychological finding is that the phantasies about death show that it is not always thought of in connexion with hostility and aggression, although this frequently occurs; but that it may appear as the opposite polarity to birth, and hence be associated with rebirth. But it is a pity that further phantasy material should not have been obtained from the same children to demonstrate more clearly what appears to be an emergence of Jungian archetypes.

From the practical point of view, it appears that the idea of death occurs quite readily to children aged 5–6 and upwards; and that therefore for adults to try and shield them from all thought of it is as unnecessary as, to-day, it is impossible. Even when feelings of anxiety and guilt have been aroused by the death of someone closely associated with the child, these fears may be allayed by free and open discussion of the subject, couched in objective terms; more particularly since the child often at such a time tends to repress his guilt phantasies.

This is a book well worth reading by anyone interested in children and the development of their ideas and phantasies; it is to be hoped that some day work may be carried further on the same lines.

L'Enfant et l'Adolescent Instables. Par JADWIGA ABRAMSON. Paris: Alcan (Presses Universitaires de France). 1940. Pp. xix+390.

This is a detailed study of about eighty cases from a Psychological Clinic in Paris of the 'unstable' child—by which is meant the child who shows chronic marked restlessness and excitability accompanied by emotional instability. This, the author thinks, constitutes a definite psychopathic type; and it seems to correspond well to the 'low perseverator'. Binet test performances, case histories and studies of behaviour showed that (1) intelligence was on the average not much below normal, but was irregular and uncertain in manifestation; (2) attention was wandering, concentration and perseverance poor; (3) activity was impulsive, restless and uncontrolled, and the child was always changing from one thing to another; (4) social and emotional qualities were undeveloped and there was a marked tendency to childish negativism. Both innate and environmental factors seemed to be operative in producing this type.

Although it could sometimes be improved by suitable psychotherapeutic treatment, on the whole prognosis was poor, and such individuals when adult found difficulty in keeping a job, were subject to fugues and might degenerate into vagabondage. Altogether this is an interesting study of these 'unstable' individuals. Whether they constitute a particular and definite type of 'psychopath' is difficult to say without a more profound analysis of their underlying psychological constitution.

Juvenile Delinquency. By J. H. Bagot. With an Introduction by D. Caradog Jones. Issued under the auspices of the School of Social Sciences and Administration in the University of Liverpool. London: Jonathan Cape, Ltd. 1941. Pp. 93. 5*s*. net.

The argument of this book is based in the main on the old question and answer: "What is wrong with the poor? Poverty!" From the point of view of social betterment, any stress laid on the high incidence of juvenile delinquency among the unemployed and overcrowded slum population of great cities is valuable. Mr Bagot shows that among the cases of juvenile delinquency occurring in Liverpool in the years 1934 and 1936, 86 % lived in families with incomes falling below Rowntree's poverty line; 30 % lived in overcrowded conditions; and about 60 % were unemployed.

But when considering the problem of how to deal with young offenders, it is important to take psychological factors into account. It is clear that the present system is ineffectual; about one-third of these young offenders become recidivists. Mr Bagot urges the extension of the Probationary system and of Club facilities. Valuable as these are, there is little doubt that many of the children need treatment at a psychological clinic. It is idle to say that because the children in the better social classes do not appear in the courts, therefore juvenile crime is a matter solely of social class. The better-off parents can keep their children out of the courts; they do not prevent the psychological maladjustment of which juvenile crime is only one of the symptoms.